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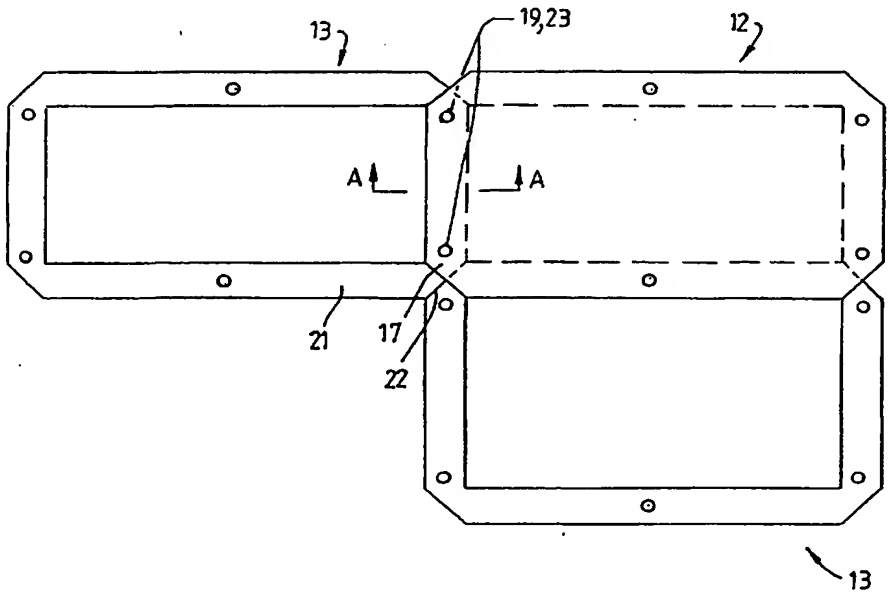

(57) Abstract: A method and apparatus for moulding concrete walls and for forming a mould assembly for moulding concrete walls using a pair of spaced moulds (11) formed by a plurality of mould panels (12) and (13) which have peripheral portions which overlap. Interconnecting pins (28) extend between the moulds (11) passing through the overlapping portions of the panels (12) and (13) to interconnect at least adjacent side by side mould panels (12) and (13) and space the moulds (11) from each other. Support frames (48), (49) or (60) form a supporting grid to support the moulds (11) at least at one side in an upright attitude.

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MOULDING OF CONCRETE WALLS

Technical Field

This invention relates to a method and apparatus for the construction of walls from a settable material such as concrete.

Background Art

Solid walls of building can be constructed using a number of methods with one common method being the use of bricks for forming a brick veneer wall. Walls constructed in this manner are relatively expensive and time consuming to construct. Where solid concrete walls are constructed, concrete formwork is custom made to suit the particular wall to be constructed. This formwork is only used once and is very expensive, resulting in an expensive end product.

Summary of the Invention

The present invention aims to provide an improved method and apparatus for constructing walls of concrete or other settable material and in particular an improved method and apparatus which enables walls to be constructed efficiently and with reduced costs as compared to current construction costs.

The present invention thus provides in one aspect, a method of constructing a wall of concrete or other settable material, said method including the steps of

providing first and second moulds, each said mould comprising a plurality of mould panels, each said mould panel having a moulding surface,

arranging said mould panels relative to each other such that peripheral portions of adjacent said mould panels overlap and said moulding surfaces are substantially coplanar to define mould faces of said first and second moulds,

providing interconnecting means for holding said moulds at a desired spacing to define a mould cavity therebetween, said interconnecting means extending through said overlapping portions of said mould panels to interconnect at least adjacent side by side mould panels in each said mould,

depositing concrete or other settable material into said mould cavity to form said wall, and

removing said moulds after curing of said concrete or settable material.

In another aspect, the present invention provides a method of erecting a mould assembly for constructing a wall of concrete or other settable material, said method

including the steps of providing first and second moulds, each said mould comprising a plurality of mould panels, each said mould panel having a moulding surface,

arranging said mould panels relative to each other such that peripheral portions of adjacent said mould panels overlap and said moulding surfaces are substantially coplanar to define mould faces of said first and second moulds,

providing interconnecting means for holding said moulds at a desired spacing to define a mould cavity therebetween, said interconnecting means extending through said overlapping portions of said mould panels to interconnect at least adjacent side by side mould panels in each said mould.

Preferably, the moulds and mould panels in each mould are interconnected in such a manner as to prevent movement of said faces transversely away from each other but permitting limited movement of the panels longitudinally relative to each other. Mould panels of each mould are usually arranged both in a horizontal end-to-end relationship as well as panels one above the other in a vertical relationship and the interconnecting means may also interconnect panels either directly or indirectly in a vertical relationship to prevent their vertical separation. Panels vertically are suitably aligned one above the other.

The methods may include the step of providing flexible or elastic means between mating ends of adjacent panels to accommodate limited longitudinal movement of the panels relative to each other where the mould panels are formed of a material with high thermal expansion properties. The flexible or elastic means also forms a seal between adjacent panels. Where mould panels formed of low thermal expansive materials are used, such flexible or elastic means may not be required. Typically, a wall constructed using the methods of the invention is formed upon an existing floor defined for example by a concrete slab and an impervious membrane or layer may be provided between the floor and moulds to permit the constructed wall to move relative to the slab. Preferably, the method of construction includes the step of providing reinforcing between the moulds prior to depositing of the concrete or settable material. The reinforcing may be connected to the floor in such a manner as to allow limited movement of the reinforcing relative to the floor with movement of the wall.

Preferably, the interconnecting means comprise elongated connectors and the panels include in their peripheral portions, apertures which are aligned with each other

when the peripheral portions overlap, and the method includes the step of passing opposite ends of the elongated connectors through the aligned apertures to interconnect the panels and moulds. The method of construction also may include the step of providing flexible or elastic elements for example in the form of bushes in at least some of the apertures to receive the ends of the connectors and allow limited movement of the panels relative to the connectors. The method of construction may also include the step of removing the ends of the elongated connectors after curing of the concrete or other settable material.

The present invention in a further aspect provides apparatus for forming walls of concrete or other settable material, said apparatus including first and second moulds, each said mould having a mould face defined by a plurality of mould panels, each said mould panel having a moulding surface, the peripheral portions of adjacent said mould panels overlapping each other and said moulding surfaces being substantially coplanar to define mould faces of said first and second moulds, and interconnecting means holding said moulds at a desired spacing to define a mould cavity therebetween, said interconnecting means extending through said overlapping peripheral portions of said mould panels to interconnect at least adjacent side by side said mould panels

Preferably, the interconnecting means permits limited movement of the mould panels relative to each other in a longitudinally direction relative to each other.

Preferably the moulds are supported in an upright position by a support frame or post. Suitably, a plurality of support frames or posts are provided and adjacent support frames or posts are interconnected by elongated spanning members. The spanning members set the length of the panels so as to be the same as the reinforcing within the panels.

The mould panels in one form may be of a rectangular planar configuration are preferably provided with a plurality of apertures in their peripheral portions for cooperation with the interconnecting means. Apertures are at least provided at or adjacent the corners thereof. Apertures may also be provided along the upper and lower edges of the panels and suitably centrally of the panels. The interconnecting means suitably comprise in one form elongated connectors which extend into selected aligned apertures in mould panels in the first and second moulds. Preferably, the elongated connectors are provided with flanges which abut the mould surfaces of the panels to set the spacing between the moulds. Preferably, the elongated connectors have spigot-like ends which

extend through the panel apertures (and support frames or posts where used) and stop means are engageable with the ends to hold the panels (and support frames or posts where used) to the elongated connectors. Preferably the stop means are spaced from the flanges a distance such as to allow the longitudinal movement of the mould panels. Preferably, the ends adjacent the flanges are of an enlarged diameter to form bosses for receipt in the panel apertures, the bosses being of a length slightly greater the width of a pair of joined panels at the apertures. Preferably, the ends are separable from the remainder of the elongated connectors. The ends are preferably separable at the flanges to leave a surface substantially flush with the outer surface of the wall being moulded. Preferably, the connection between the spigot-like ends and remainder of the elongated connectors is necked adjacent the flanges to so that the ends of the elongated connectors may be easily broken off by twisting. For this purpose, the ends of the elongated connectors may be shaped for engagement by a suitably tool such as a wrench which can be used to twist off the ends of the elongated connectors. Preferably, the ends of the elongated connectors have one or more flats and the socket has a corresponding cross section for neat receipt of the end whereby the tool may be twisted by gripping of the handle to effect breaking off of the end.

In an alternative configuration, the ends of the elongated connectors may be threaded and the stop means comprise nuts which may be threadably engaged with the threaded ends of the elongated connectors.

Preferably, the ends of the elongated connectors include at least one slot for receiving a stop member therethrough defining the stop means which secures the elongated connectors to the panels and/or support frames and posts. Preferably, the stop member is of a tapering or wedge-shaped configuration such that it may be wedged into the slot. Preferably a pair of spaced slots are provided in one or both ends such that the stop member can be placed in different positions in the end depending upon whether the connectors pass through a support frame/post.

In another arrangement, the elongated connectors may be in at least two parts comprising an outer sleeve part having shoulders or flanges at each end which are arranged in use to abut the inner mould faces. The other part comprises an elongated pin which is receivable in the sleeve part, the opposite ends of the pin extending outwardly at opposite ends of the sleeve part to define spigot-like ends. The pin may be held within the

sleeve part by an interference fit. The spigot-like ends may be of similar configuration to the previously mentioned spigot ends being provided with slots therein to accept stop members or provided with threads to accept threaded nuts which serve as stop members to retain the mould panels (and support frames where used) to the pins. The pin may also be provided in two parts comprising an inner pin member having one or more slots or threads at each end and an outer tubular sleeve member surrounding the inner pin member and an interference fit therewith. The outer tubular sleeve member suitably is of a length greater than the outer sleeve part such that projecting ends of the sleeve member defining the bosses for location in the apertures in the panels.

After moulding, the stop members or nuts are removed permitting the pins to be withdrawn from the outer sleeve parts leaving the outer sleeve parts within the formed wall. Ends of the sleeve part may be plugged by suitable bungs.

Most preferably, the apertures in the panels which receive the ends of the elongated connectors are of a greater diametrical dimension than the ends of the elongated connectors and may be formed to accept a flexible bush or insert into which the ends project such as to centralize the elongated connectors within the apertures and allow expansion movement of the panels. The flexible bushes or inserts are used where required to allow for movement of the panels which may result from exposure of the mould panels to the sun, the mould panels having an expansion rate substantially greater than the expansion rate of a floor slab or other foundation upon which the wall is moulded. The flexible bushes or inserts also serve as a seal to prevent escape of the settable material around the pins.

The panels suitably are of two configurations to enable joining thereof and for forming a substantially planar mould face. In one arrangement, the panels are suitably recessed around their perimeter to define in each panel a peripheral flange and the panels are arranged in an opposing relationship and flanges mate with each other to form the moulds. In this configuration, the peripheral flanges of the panels are provided with the apertures which can align when the flanges mate with each other. Preferably, the respective corners of the panels are truncated at 45 degrees to allow cooperation diametrically with adjacent panels. The panels rearwardly of their mould surfaces are preferably reinforced to provide sufficient stiffness to the mould surfaces to prevent deformation thereof during moulding. Preferably, the reinforcing is formed by a plurality

of intersecting webs. The flanges may also be provided with reinforcing webs as in the panels with bosses formed around the apertures in the flanges. The panels are suitably formed of plastics, glass reinforced plastics, or any other suitable material such as timber or a timber moulding.

In a further form, the mould panels may be of a curved configuration to enable the construction for example of curved walls for example for the construction of tanks of circular configuration or any other curved structure. The mould panels in other respects are apertured in a similar manner to the planar panels and may be interconnected in the same manner as described above.

In construction of a wall, suitable reinforcing is provided between the moulds prior to pouring of the concrete or other settable material. Preferably, the reinforcing includes a plurality of vertical reinforcing members and a plurality of horizontal reinforcing members. The vertical reinforcing members may be secured to upwardly projecting starter bars around which resilient sleeves may be provided to allow for independent expansion movement of the wall. Where the wall is to be erected on a slab, the slab may be provided with a plurality of starter bars which project upwardly out of the slab and the vertical reinforcing members may be attached to the starter bars. The vertical reinforcing members may be wired to the starter bars or may be connected through a threaded connection to the starter bars.

In an alternative arrangement, the floor slab may be provided with reinforcing mounts to which the vertical reinforcing members may be attached, the mounts allowing limited movement of wall relative to the floor slab. The mounts may comprise a base member which is anchored in the slab and a coupling member which is supported for limited horizontal and vertical movement relative to the base member. Preferably, the coupling member includes a coupling plate carrying a socket for engagement by a vertical reinforcing member and the base member captures the plate. Most preferably, the base member includes first and second plates located above and below the coupling plate. The socket suitably projects above the slab and a cover seals the socket to the base member to prevent ingress of concrete into the mount. Preferably also means are provided between the coupling plate and base member to facilitate sliding movement of the coupling plate relative to the base member and also allow the mount to be installed out of square. Resilient pads may also be provided to limit movement of the coupling plate.

Whilst the reinforcing mounts are particularly suited to the present application, it will be appreciated that they also may be used in the construction of walls of other configuration and used in other applications such as earthquake applications to allow limited movement of a wall relative to a floor such as a floor slab and absorb energy.

Both the mounts and resilient sleeves are suitably used in combination with a membrane or layer which is applied to a floor such as a slab floor prior to pouring of the concrete or other settable material. This will allow for expansion or other movement of the wall relative to the floor.

Where the walls are moulded in areas not frequently subject to earthquakes, walls may be moulded directly onto the slab without the use of a membrane between the wall and slab or the use of resilient sleeves or the reinforcing mounts. Building standards and codes in these areas generally do not require the use of such components.

For erection of an internal wall on a slab where no starter bars or reinforcing is used to prevent the mould panels riding upwardly during moulding, mould panels may be assembled as described above to define a pair of moulds and clamping means may be provided to clamp the moulds to the floor upon which the wall is to be erected. The clamping means may comprise clamp rods located on opposite sides of the moulds and engage with a clamp member located on top of the moulds. The clamp member may comprise flexible pads to prevent the moulds from being damaged. At their lower ends, the clamp rods may engage with brackets secured to the floor. The brackets may extend beneath the moulds. Projecting ends of the brackets on either side of the constructed wall may be severed after removal of the moulds. Internal walls may be constructed with a reinforced concrete such as fibre reinforced concrete thereby eliminating the need to use steel reinforcing. If desired however steel reinforcing can be used and internal walls can be constructed over starter bars.

Door openings may be formed in walls during the moulding process by the placement of door frames between the opposite moulds to engage the mould faces such that during construction of the wall, the concrete or other settable material only fills the mould cavity up to the door frame. In some cases, mould panels within the door frame opening may be removed or not included when the moulds are assembled. Where door openings are formed in a wall, a reinforcing link may be provided in the floor slab beneath the opening to prevent cracking around the opening in the event that movement occurs

between the wall and slab. The reinforcing link may be located within a trench in the floor slab and tied off at each end to the reinforcing within the mould cavity prior to formation of the wall. The trench may be covered by suitable cover plates.

For longer wall lengths, expansion joints may be needed to be incorporated into the moulds to separate the moulds into mould sections. The expansion joints suitably include first and second complementary end members which are secured to adjacent mould sections. The complementary end members may include co-operable configurations such as a protuberance which locate within a complementary recess to maintain longitudinal alignment of the mould sections. Resiliently compressible means may be provided between the complementary end members. The end members may be secured to the inside of the mould panels of the moulds to be retained after moulding of the wall section on each side of the expansion joint or alternatively, the end members may be secured to the outside of the mould panels to be detachable after moulding of the wall sections.

Means may be provided to limit longitudinal movement of the wall sections on opposite sides of an expansion joint away from each other. Such means may include one or more links fixed to the adjacent wall sections by suitably fixing anchors passed through apertures in the links. One of the apertures may be of elongated form to accommodate limited movement of the wall sections.

For defining a buttress wall, an end member of similar overall configuration of the end members for the expansion joint but having a planar end face may be employed, being secured to the ends of a moulds during the moulding process.

Corners in a wall may be manufactured by means of angled corner panels usually of right-angled configuration joined to the spaced moulds defining the wall. The corner panels may be joined to the moulds by bridging members joined to the panels and corner panels by the elongated connecting members.

T-junctions may be established similarly by means of panels defining a T-shape and comprising a first planar rear panel and a pair of opposed angle panels of right-angled configuration. The rear panel may be placed in alignment with the mould panels of one wall mould and joined thereto whilst the pair of angle panels is joined to the mould panels of the other wall forming mould and to other moulds defined by joined mould panels to defining a walls extending at right angles to each other. The panels defining the T-junctions are suitably joined to the mould panels of the walls by bridging members and the

elongated connecting members.

For forming or defining window openings within a wall formed by the mould panels, a pair of spaced apart aligned frames are provided adjacent opposite moulds surrounding the desired window opening. Infill panels may be provided between opposite frames and fit over the mould panels to define the window opening, concrete or other settable material filling the cavity between the moulds up to the infill panels during formation of the wall, the panels and the frames being removed after formation of the wall to leave the window opening within the wall. In an alternative arrangement for forming or defining window openings, a rectangular frame may be located in the cavity between the moulds, the frame extending between the opposite moulds. The lower frame member of the frame which defines or is adjacent the window sill may be provided with one or more holes to enable depositing of concrete beneath the frame member. Cover plates may be attached to the frame member over the holes to seal the holes and permit continued moulding of the wall. The cover plates may be provided with removable blanking plates which fit within the holes. The cover plates may be removed leaving the blanking plates within the holes after moulding. The frames may be collapsible to enable them to be removed from the wall after moulding or may remain in situ within the moulded wall.

The formwork mould panels are reused where possible and are produced by processes enabling mass production to reduce costs. Labour content using the system in erection of walls is also less than current methods and recycled or recycleable plastics or other materials may be used wherever possible in the moulding system components. The finished concrete walls require no pest treatment thus saving possible termite damage as encountered in timber structures.

Different means other than that described may be provided for mounting the walls to the floor slab and where the reinforcing mounts are used, different flexible components may be used within the mounts. Window openings may either be moulded plain or with a rebate to locate windows. All components may be made of any suitable material or made by any suitable method. Different shapes may also be moulded into the walls formed using the method and apparatus of the invention by the use of suitably shaped moulding members or inserts between the moulds. For example, angled inserts may be used to define gables or curved inserts provided to define arches.

In yet a further aspect the present invention provides a method of erecting a mould

assembly for constructing a wall of concrete or other settable material, said method including the steps of arranging at least one pair of mould panels in a desired spacing to define a mould cavity therebetween, said mould panels having apertures therein, the apertures in the respective mould panels being transversely aligned with each other, providing flexible elements within said apertures, providing interconnecting means between said mould panels for holding said mould panels at said desired spacing, said interconnecting means extending through said flexible elements and apertures in said spaced mould panels, whereby to permit limited longitudinal movement of said mould panels relative to said interconnecting means.

Preferably, the method includes the step of arranging a plurality of mould panels in an edge-to-edge mating relationship and providing flexible or elastic means between mating edges of the mould panels to accommodate said limited longitudinal movement thereof. The method preferably also includes the steps of providing a plurality of upright support means for supporting said mould panels in an upright attitude, and securing the interconnecting means to the support means on at least one side of said mould panels. The method also may include the step of providing elongated spanning members for spanning and interconnecting the upright support means to form a support grid for the panels.

The present invention in yet a further aspect provides a connector pin assembly for connecting a pair of spaced apart mould panels defining a mould cavity therebetween, said mould panels being provided with transversly aligned apertures, said connector pin assembly comprising a pin having opposite ends receivable in said panel apertures, and a spacing member surrounding said pin and adapted to abut inner opposite faces of said panels to space the panels from each other. Preferably, the spacing member is a sleeve-like member which may be an interference fit with the pin and having shoulders or flanges at each end for abutting the faces of the panels. The pin may also be provided in two parts comprising an inner pin member and an outer tubular sleeve. Opposite ends of the pin or pin member are suitably adapted to be engaged by stops to retain the panels to the pin or pin member. For this purpose, the pin or pin member may be provided with one or more slots at each end to receive retaining wedge members. Alternatively, the ends of the pin of pin member may be threaded for receipt of threaded retainers.

Brief Description of the Drawings

In order that the invention may be more readily understood and put into practical

effect, reference will now be made to the accompanying drawings which illustrate a preferred embodiment of the invention and wherein :-

Fig. 1 illustrates schematically in exploded view the moulding method and apparatus according to the invention;

Figs. 2(a) and (b) illustrate in side and end views, one form of mould panel for use in the method and apparatus of the invention;

Fig. 3(a) and (b) illustrate in side and end views a second form of mould panel which is complementary to the panel of Fig. 2 shown in opposite views to the views of Figs. 2(a) and (b);

Figs. 4 (a) and (b) illustrate portion of a modified form of panel;

Fig. 5 illustrates the manner in which mould panels interlock;

Fig. 6 is a sectional view along line A-A of Fig. 5;

Fig. 7 is a sectional view illustrating the manner in which the panels are interconnected by connecting pins;

Fig. 8 illustrates a connecting pin for interconnecting the panels in the direction B of Fig. 7;

Fig. 9 is an end view of the connecting pin;

Fig. 10 is an enlarged view of the region C of Fig. 7;

Figs. 11 (a) and (b) illustrate in plan and elevational views, a break-off tool for use with the connecting pins;

Fig. 12 illustrates the end of an alternative connecting pin;

Fig. 13 illustrates a nut for use with the pin of Fig. 12;

Figs. 14, 15 and 16 illustrate in side view, alternative support frames for the mould panels;

Fig. 17 illustrates in enlarged sectional view a typical leveling screw for use with the support frames of Figs. 14 and 15;

Fig. 18 illustrates the typical configuration of reinforcing between the moulds and methods of flexibly connecting reinforcing for the walls to a floor slab;

Fig. 19 is a side view of the assembled panels, starter bar configurations and resilient sleeves;

Figs. 20 and 21 illustrate in sectional and plan view a sliding mount for the

reinforcing for the walls;

Fig. 22 illustrates the lower end of a mould raised above a floor;

Fig. 23 illustrates an infill panel for use between the mould panels and floor;

Figs. 24 and 25 illustrate in cross sectional and plan view, a hold down arrangement for the panels for construction of an internal wall where no starter bars or reinforcing is used; and

Fig. 26 illustrates an alternative hold down arrangement for the panels.

Fig. 27 illustrates the manner in which door frames may be installed during construction of a wall according to the present invention;

Fig. 28 illustrates a subfloor link arrangement for use beneath door openings;

Fig. 29 is an enlarged view of the region D of Fig. 28;

Fig. 30 illustrates in plan view an arrangement for incorporating an expansion joint into walls during the moulding thereof;

Figs. 31(a) and (b) illustrate the end connectors for use in the expansion joint;

Fig. 32 illustrates in plan view an alternative configuration of expansion joint;

Fig. 33 illustrates expansion joint limiters at the expansion joint between wall sections;

Fig. 34 illustrates the method of forming a buttress wall;

Fig. 35 illustrates in plan view a corner configuration;

Fig. 36 illustrates in isometric view a corner connector;

Fig. 37 illustrates in plan view a T-junction configuration;

Fig. 38 illustrates in isometric view a T-junction connector;

Fig. 39 illustrates in elevational view a bridging plate for connection wall panels to the connectors of Figs. 36 and 38;

Figs. 40 and 41 illustrate in side and plan views, apparatus for defining a window within a wall being moulded;

Fig. 42 is an exploded view showing the components of the window defining frame assembly of Figs. 40 and 41;

Fig. 43 illustrates in plan view an alternative window mould panel;

Fig. 44 is a view in the direction E of Fig. 43;

Fig. 45 illustrates in side view alternative side panels for the window moulds;

Fig. 46 illustrates the panel configuration at a corner of the window defining frame assembly ;

Fig. 47 and 48 illustrate in side and isometric view, the panels at a window corner moved apart;

Fig, 49 illustrates a conduit at a slab junction;

Fig. 50 illustrates in part sectional view, an alternative connection pin assembly for connecting moulds and mould panels;

Fig. 51 illustrates in longitudinal sectional view, the sleeve of the connection pin assembly of Fig. 50 and associated end plugs;

Fig. 52 is an end view of the sleeve of Fig. 51;

Fig. 53 illustrates in side view a window defining frame located in a mould cavity between moulds;

Fig. 54 is a view of the frame in the direction G of Fig. 53;

Fig. 55 illustrates the manner in which a gable can be constructed;

Fig. 56 illustrates in exploded view an alternative method for supporting and erecting mould panels for constructing a wall forming mould; and

Fig. 57 is a part sectional view showing the assembly of mould panels of the method of Fig. 56.

Detailed Description of the Preferred Embodiment

Referring to the drawings and firstly to Fig. 1, there is illustrated schematically apparatus 10 for erecting walls according to the invention. The apparatus 10 includes a pair of opposite moulds 11, each defined by a plurality of interconnected mould panels 12 and 13, the interconnected panels 12 and 13 defining planar moulding faces 14 of the moulds 11. The moulding faces 14 however may be textured to create a textured face in the erected wall. The panels 12 as shown in Fig. 2 are in this embodiment of a generally rectangular configuration and suitably are moulded from glass filled plastic but may be made by any means or from any suitable material. Panels 12 and 13 are configured to interlock with each other in an end-to-end relationship and top to bottom relationship.

The panel 12 as shown in Figs 3(a) and (b) defines on one side, a moulding surface 15 which is reinforced by a rectangular configuration of webbing 16 on the rear side of the surface 15, the webbing 16 defining peripheral flanges 17 of suitable width (W) for overlapping and cooperative engagement with an adjacent panels 13. The flanges 17 may also be reinforced by webbing 16' in a similar manner on the sided thereof opposite the moulding surface 15. The corners of the flanges 17 are truncated at 45 degree as at 18 to truncate the corners of the rectangular moulding surface 15 to enable interlocking with adjacent panels 13 as shown in Figs. 4 and 5. Holes 19 are provided in the flanges 17 of the panels 12 for interconnection with the panels 13 as described further below, the reinforcing webbing 16' forming bosses around the holes 19. The number of holes 19 may vary depending on the requirements.

The panels 13 as shown in Figs. 3(a) and (b) have a moulding surface 20 of rectangular configuration of a size substantially equal to the surface 15 less the width of the flange 17 of the panel 12. The surface 20 is stepped forwardly of a surrounding peripheral flange 21 having a width "W" by a distance substantially equal to the thickness of the flange 17. As with the panel 12, the flange 21 is truncated at 45 degrees at the corners 22 and includes holes 23 in the flange 22 positioned for alignment with the holes 19 in the flange 17 of the panel 12. The mould surface 20 can be reinforced by webbing 24 on the rear side thereof and similarly the flanges 21 can be reinforced by webbing 24' which also forms bosses around the holes 23.

For the bottom top and ends of walls, flanges of the mould panels 12 and 13 may be deleted as shown in Figs. 4(a) and (b) to define plain edges 25 and 26 for the panels. The plain edges 25 and 26 are located at the top and bottom and ends of the walls or at corners of the walls to define a square corner.

Whilst the panels 12 and 13 are shown to be of different configurations they may be constructed identically for example if they are of a solid form or provided with an external skin surrounding for example a foam core with panels 12 and 13 arranged in an opposite relationship relative to each other with opposite faces thereof defining opposite mould surface. Because the alternate panels 12 and 13 shown in the drawing, however are handed as shown in Figs. 2 and 3, colour coding or the use of numerals, letters or symbols may be used to identify the different panels to ensure that they are assembled correctly.

Panels 12 and 13 are arranged as shown in Figs. 5 and 6, with, in side-by-side panels 12 and 13, the flange 17 of one panel 12 overlapping the flange 21 of the other panel 13 and with the respective holes 19 and 23 being aligned. Similarly in upper and lower panels 12 and 13, the flanges 17 of the panels 12 overlap the flange 21 of the other panels 13. In diagonally arranged identically panels 12 or 13, the truncated corners 22 or 18 of adjacent panels 12 or 13 are juxtaposed. As is apparent in Fig. 6, the mould surfaces 15 and 20 of interconnected panels 12 and 13 are coplanar and panels 12 and 13 are arranged alternatively one above the other in a non-staggered relationship and similarly alternatively in a side by side relationship. A flexible adhesive tape 27 of any suitable specification may be placed around the circumference of every alternate panel 12 or 13 including between juxtaposed truncated corners 18 and 22. This caters for expansion of the mould panels 12 and 13 which is expected to be more than the concrete. Alternatively the flexible adhesive tape may be any suitable flexible material of any section that may mate with a suitable section around the circumference of every alternate panel 12 or 13.

The panels 12 and 13 in the opposite moulds 11 are interconnected by means of a plurality of transverse connector pins 28 which additionally extend between the moulds 11 and hold the moulds 11 at a required spacing to form a mould cavity 29 into which concrete or other settable material is poured. The transverse connector pins 28 as shown in Figs. 7 to 9 are of elongated form and provided with integrally formed spaced apart flanges 30 that serve to fix the spacing between the moulds 11 by abutting against the mould faces 14 of the moulds 11. The pins 28 also have spigots 31 at each end extending outwardly of the flanges 30, the spigots 31 having enlarged bosses 32 of a length slightly greater than width of joined panels 12 and 13 so as to permit mould panels 12 and 13 to move relative to each other to a limited extend as described further below. The outer ends of the spigots 31 are provided with a pair of spaced slots 33 and 34 which extend through the spigots 31. The pins 28 however may only include one slot 33 at one end and a pair of slots 33 and 34 at their opposite ends or single slots 33 at each end depending upon the method of supporting the panels 12 and 13 during moulding as described further below and where the pins 28 are to be used. The bosses 32 are joined to the flanges 30 via undercut portions 35 (see Fig. 10) which facilitate the breaking off of the spigots 31 as described further below. The ends of the spigots 31 are formed with opposite flats 36 for engagement with a complementary socket 37 of a break off tool 38. Wedge shaped

members 39 of a thickness slightly less than the thickness of the slots 33 and 34 are provided for insertion into the slots 33 and 34. The flanges 30 may be provided with opposite flats 40 to prevent rotation of the pins 28 during the break-off procedure as described below. The pins 28 are typically moulded from plastic but may be of any suitable material.

The holes 19 and 23 are of a greater diameter than the diameter of the bosses 32 and some or all of the holes 23 in the panel 13 (and holes 19 in the panels 12) may be counter bored at 41 to receive flexible bushes or 'O' rings 42. The flexible bushes or 'O' rings 42 are located at suitable locations and are provided to centrally locate the transverse connector pins 28 within the aligned holes 19 and 23 in the panels 12 and 13 to permit the mould panels 12 and 13 to move relative to each other to a limited extend to control overall expansion.

An alternative configuration of pin 28 is shown in Fig. 12 in which like components to the components of the pin 28 have been given like numerals, the spigot 31 may be formed with first and second threaded sections 43 and 44, the threaded section 43 being arranged adjacent to the boss 32 and the threaded section 44 being at the free end of the spigot 31. The threaded section 43 has a larger diameter than the threaded section 44. The threaded section 43 terminates at a shoulder 45 at the junction with the boss 32 and the threaded section 44 terminates at a shoulder 46. The threaded sections 43 and 44 are arranged for threaded cooperation with a pair of nuts, only one of which 47 is shown in Fig. 13. The nut 47 for engagement with threaded section 43 may be passed over the spigot 31 and threaded section 44. The nuts 47 when urged into engagement with the shoulders 45 or 46 and with torque applied will cause the spigot ends to break off at the undercuts 35. For tightening and break-off purposes, the nut 47 has opposite flats for engagement with a suitable tool such as a spanner. In an alternative arrangement, the nuts 47 may be conventional hexagonal nuts. The distance between the flange 30 and shoulders 45 and 46 is such as to allow limited longitudinal movement of the panels 12 and 13 when secured to the spigots 31 by the nuts 47.

To support the moulds 11 and mould panels 12 and 13 during the wall construction process, support frames 48 and 49 of alternative configurations may be employed as shown in Figs. 1, 14 and 15. The support frames 48 are braced frames and include a horizontal member 50 and a braced vertical member 51. The support frames 49 are

unbraced frames and also include a horizontal member 52 and an upright member 53. The upright members 51 and/or 53 of adjacent frames 48 or 49 are tied together by elongated spanning members 54 which may be of angle section form. The horizontal members 50 and 52 of the frames 48 and 49 may be provided with levelling screws 55 (see also Fig. 17). The levelling screws 55 are threaded into threaded bushes 56 secured within the horizontal members 50 and 52 which are preferably of tubular form and drilled to accept the bushes 56. Screws 57 secure the bush 56 to the members 50 or 52. The levelling screws 55 have a reduction spigot 58 so designed as to be able to be peened over to accept a platform washer 59 which is allowed to rotate. The levelling screws 57 enable the frames 48 and 49 and attached wall panels 12 and 13 primarily to be jacked up as well as allowing vertical adjustment of the wall panels 12 and 13 after they have been jacked up. In a simplified form, the frames 48 and 49 may be provided with no levelling screws and the frame 49 may also be provided without the leg 52 thereby forming a simple post. The frames 48 and 49 are typically constructed of steel. The frame 48 may be designed to fold at strategic locations for ease of transport.

An alternative support frame 60 is shown in Figs. 1 and 16, the frame 60 including a normally upright member 61 pivotally connected at 62 to a horizontal member 63. The horizontal member 63 may be provided at its outer end with an outrigger foot 64. The members 61 and 63 may be held at an adjustable angle via an adjustable split diagonal rod 65 pinned to the members 61 and 63 by pins 66 and 67. A turnbuckle 68 is provided intermediate the ends of the split rod 65 which when rotated in opposite directions will extend or retract the length of the rod 65 and thus vary the attitude of the upright member 61 relative to the horizontal member 63. The support frame 60 will be preferred in most situations as it allows for vertical adjustment of the moulds under all situations to ensure that the wall is constructed vertically. The support frame 60 may also have levelling screws as used on the frames 48 and 49 as referred to above.

The upright members 51, 53 and 61 are provided with apertures 69 spaced apart the distance between the apertures 19 and 23 in the panels 12 and 13 in the vertical direction to allow connection by the pins 28 as described further below.

Referring to Figs. 1, 18 and 19, a wall constructed using the apparatus 10 according to the present invention may be moulded directly onto a floor slab 70 having protruding starter bolts or bars 71. If differential expansion exists or is expected between

the slab 70 and the wall, the wall may be moulded about flexible junctions or sleeves 72 located about the starter bolts or bars 71.

The starter bars 71 come directly out of the floor slab 70 and may have right angle bends 73 (which may be formed on site) to lock into the concrete of the wall as shown or have a screwed connector 74 into which vertical reinforcing rods 75 are screwed. In the case of a starter bar with a bend 73, a vertical reinforcing rod 75 may be tied to it by suitable ties 76. The flexible sleeves 72 may be longitudinally split to allow fitment if a starter bar 71 with a right angle bend is used.

In an alternative arrangement, starter bars 71 may be fixed in sliding mounts 77 (see Figs. 18, 20 and 21 which are cast within the slab 70 to accommodate relative movement between the wall and slab 70. The mount 77 is designed to be cast into the floor slab 70 and allow expansion movement of the wall moulded over it. It can also provide some energy absorption during earthquake. The mount 77 includes a ferrule 78 fixed onto a disk 79 or alternatively those components may be integrally formed. Disk 79 is assembled between two other disks 80 and 81 which are located at a certain distance apart by annular ring 82 which creates a design clearance 83 at the top and bottom of the disk 79. Disks 80 and 81 include grooves 84 in which flexible rings 85 are carried which may be of any section or round and which may be 'O' rings or any special design. The flexible rings 85 bear on the plate 79 on opposite sides to support the plate 79 in its sliding movement. The rings 85 also serve as energy absorbers where the mount 77 is used for example in earthquake environments.

The design clearances will enable the disc 79 to slide freely radially and to prevent any jamming if the mount 77 is installed slightly off vertical, thereby allowing some installation tolerance. A cap 86 typically formed of plastics is designed to securely clip and locate into a central hole 87 in the top disk 80, the hole 87 having a chamfer 88 around its periphery. The cap 86 has a hole 89 at its upper end that locates tightly about the ferrule 78. The cap 86 prevents wet concrete ingress into the mount and centres the sliding mount 77 during moulding. A flexible annulus 91 of any suitable material is located between the disk 79 and the annular ring 82 to allow adequate movement of disk 79 but cushion and centralise it. Alternatively, a flexible annulus 92 may be located within the cap 86 between the ferrule 78 and hole 87 in the plate 80 and perform the same function. Each annulus 91 or 92 also will serve to absorb energy which may be

encountered in earthquakes.

The chamfer 88 in the top disk 80 is designed to clear any weld between the ferrule 78 and disk 79. If the flexible annulus 91 is employed the top disk 80 may be attached with screws 93 instead of welding 94 to prevent burning of the flexible annulus 91 during welding. The annular ring 82 may be welded to the bottom disk 81. A securing bar 94 is welded to the bottom disk 81 and includes a right angled bend to embed firmly into the concrete of the slab 70. Ferrule 78 may be threaded as at 95 to accept a threaded reinforcing rod or may be plain bored to accept a rod which is in turn welded to it. The sliding coupling is self centering during moulding and is designed allow a limited radial deflection in all directions before solid contact occurs between the sliding disk or ferrule with other fixed parts of the mount 77. In use, the concrete of the wall is cast onto the floor slab 70 over the upwardly protruding cap 86 and when or if the wall moves relative to the floor slab 70, the cap 86 will break to allow this movement, the cap 86 being designed to deliberately fall in these circumstances.

For construction of a wall, flexible adhesive tape or any suitable flexible material of any suitable section is wrapped around the periphery of each alternative panel 12 or 13 and these mould panels 12 and 13 are assembled in the manner shown and described with reference to Figs. 5 and 6 with the flexible material sandwiched between opposite edge portions of the panels 12 and 13. Where mould panels 12 and 13 having plain edges 25 are used, the tape is not used on the plain edges 25. The assembled mould panels 12 and 13 are arranged at spaced apart positions on opposite sides of the starter bars 71 or mounts 77 and interconnected by means of the connector pins 28 as shown in Fig. 7 to form both moulds 11. In one option for assembly, one set of panels 12 and 13 for one mould 11 may be assembled by inserting the spigot ends 31 of the pins 28 into the aligned apertures 19 and 23 where they may be held by the bushes 42. The other set of panels 12 and 13 for the other mould 11 may then be aligned with the aligned openings 19 and 23 therein inserted over the free ends of the pins 28 with the reinforcing arranged between the moulds 11 as the construction proceeds. Where the panels 12 and 13 are supported by frames 48, 49 and 60 on one side only, the interconnecting pins 28 need only have a single slot 33 for cooperation with a wedging member 39 to hold the panels to the pins 28 at the position remote from the frames 48, 49 or 60.

When the pins 28 are passed through the aligned holes 19 and 23 in the mould panels 12 and 13, the outer annular faces of the bosses 30 will abut against the mould faces 14 of the moulds 11 to act as spacers to hold the moulds 11 at a fixed spacing relative to each other and interconnect the panels 12 and 13 to hold the panels in an end to end relationship with each other with the mould surfaces 15 and 20 thereof coplanar. Panels 12 and 13 are also assembled one above the other and the panels 12 and 13 may be held connected to each other by further pins 28 passed through the aligned holes 19 and 23 in the centre of the panels 12 and 13. The assembled panels 12 and 13 are supported on one or both sides by the support frames 48, 49 or 60 with the spigots 31 of the pins 28 passing through the apertures 69 in the upright members 51, 53 or 61 of the support frames 48, 49 or 61. The panels 11 and 12 are held to the upright members 51, 53 or 60 by means of the wedge shaped members 39 which are passed into the outer slots 34 of the spigots 31. As stated however, the boss 32 ensures that the mould panels 12 and 13 are always free to move relative to each other in a direction normal to the pins 28 and are thus not locked up even when secured by the wedge shaped members 39 to the upright members 51, 53 and 60. The outer slots 34 are used where the frames 48, 49 and 60 are used whilst the inner slots 33 are used for receipt of the wedge shaped members 39 when it is desired to hold the panels 12 and 13 to the pins 28 in the absence of the frames 48, 49 and 60.

Alternatively, where pins 28 with ends of the type shown in Fig. 12 are employed, the panels 12 and 13 are held to the upright frame members 51,53 and/or 60 by nuts 47 engaged with the threaded portion 44 which is screwed up into abutment with the shoulder 46. In the absence of the frame members 51,53 and/or 60, a nut 47 is engaged with the threaded section 43 and screwed up to the shoulder 45. The spacing of the shoulders 45 along the spigot 31 is such that when either a nut 47 or frame member 53, 51 or 63 abuts the shoulder 45, panels 12 and 13 are free for longitudinal movement relative to each other in a direction substantially normal to the pins 28.

The leveling screws 55 when employed, are used to jack up the panels 12 and 13 if required and then adjust the upright attitude of the frame members 51 and 53 and thus the panels 12 and 13 to ensure a vertical wall. Alternatively, the turnbuckle 68 may be adjusted to adjust the vertical attitude of the panels 12 and 13 where the frames 60 are used.

The elongated members 54 which interconnect adjacent frames 48, 49 and/or 60 through the pins 38 are used to maintain the overall length of the assembled wall mould panels 12 and 13 by fixing the position of pins 28. The member 54 has holes to locate over the spigots 31 of the connector pins 28 and is also secured to the pins 28 by means of the wedges 39 (or nuts 47). In for example Fig. 7, the members 54 may be located between the frame members 51, 53 or 61 and wedge 39 which because of its configuration will adjust to the additional width of the member 54. The elongated member 54 may be of any suitable length and usually one row of members 54 on the top and bottom of the moulds 11 is required.

Where the wall is to be constructed on a floor slab 70, an impervious membrane or layer 96 which may be a sheet like material may be initially placed on the slab 70 which prevents the concrete bonding to the slab 70 thereby forming a slip joint and allows independent expansion of the concrete wall relative to the slab 70 (see Fig. 19). The impervious membrane 96 may be relatively thin however in locations where earthquakes may be encountered, the membrane 96 may be of increased thickness to absorb energy. Vertical reinforcing rods 75 are secured to the starter bars 71 or mounts 77, and horizontal steel bars 97 may be tied to the vertical bars 75 as shown in Fig. 18 at the points of crossover 98. The horizontal bars 97 may also be tied to the transverse connector pins 28 as shown at 99. For this purpose, the pins 28 may have a central aperture 100 (see Fig. 7) which facilitates tying of the bars 97 to the pins 28 at a central location within the mould cavity 29.

After assembly of the mould as above, concrete is then poured or deposited between the moulds 11 into the cavity 29 and onto the impervious membrane 96 to encapsulate the pins 28 and reinforcing 75 and 97 and the concrete is then allowed to cure. If the wall moves due to expansion during curing or after curing for example if the wall heats up to due to exposure to sunlight whilst the floor slab remains cool, it moves on the impervious membrane 96 and movement will also be accommodated by the flexible mounts 72 which allows bending of the starter bars 71 within the formed wall. Where the mounts 77 for the reinforcing bars 75 are used, the cap 86 is designed to break to allow movement of the wall relative to the slab 70.

After the concrete has cured, the wedge-shaped members 39 are removed, the break-off sockets 37 of the tools 38 are located over the ends of the projecting spigots 31

and twisted to break the spigots 31 off at the undercuts 35. This leaves the pins 28 behind in the moulded concrete wall. Where pins 28 having the threaded ends are used, a torque may be applied to the nuts 47 such that they are urged up harder against the shoulders 45 or 46 until the spigots 31 break off again at the undercuts 35. In each case, the flats 40 which are surrounded by concrete prevent the pins 28 from turning during the break off operation. Any remains of the pins 28 after breaking off may be dressed off flat with the rest of the wall. The panels 12 and 13 may be removed either before or after breaking off the spigots 31 of the pins 28.

In construction walls as above, in some instances the slab floor 70 may not be level. In this case, it is necessary to jack up the mould panels 12 or 13 via the frames 48 or 49 using the leveling screws 55 as shown in Fig. 22. This creates a gap 101 at the bottom of the mould panels 12 and 13 and a filler panel 102 is used to close the gap 101. The panel 102 as shown in Fig. 22 is shaped to slide between the mould panels 12 and 13 and pins 28 and may be made of any suitable material. The panel 102 includes spaced slots 103 which fit over the pins 28. The panel 102 prevents concrete leakage during moulding.

Figs. 24 and 25 illustrate a holding down arrangement for the moulds 11 defined by the mould panels 12 and 13 for constructing an internal wall without starter bars. Where an internal wall is not required to be tied down to the slab (i.e. no starter bolts or mounts) and/or does not contain steel reinforcing it may be necessary to tie the moulds 11 down to prevent them floating up during moulding. For this purpose, a securing plate 104 is mounted to the slab 70 in the correct location using an anchor bolt 105 and panels 12 and 13 assembled on opposite sides of the plate 104. The lower edges of the lowermost panels 12 or 13 may be required to have slots to accommodate the plate 104. This plate 104 is joggled enabling hooked rods 106 to be slid under the opposite sides thereof. The rods 106 are attached to a stirrup 107 via vertical adjusters 108 which may be turnbuckles. The stirrup 107 passes over the upper ends of the moulds 11 and flexible pads 109 may be employed above the mould panels 11 beneath the stirrups 107 to prevent the mould panels 12 and 13 being damaged. After pouring and curing of the concrete between the moulds 11, the moulds 11 may be disassembled and protruding ends of the plate 104 may be severed. If an internal wall does not incorporate steel reinforcing, the concrete for forming this wall may be reinforced with a material such as fibre.

An alternative arrangement is shown in Fig. 26 with a double joggled securing plate 110 that allows nuts 111 to be installed above and below it engaged with an elongated anchor screw 112 thereby allowing jacking up of the moulds 11 via the longer screw 112 set within the slab. This compensates for out of level of the slab or footing.

For incorporation of door openings during construction of walls using the moulding apparatus and method of the invention, frames 112 and 113 of an exact width to fit between the mould panels 12 and 13 may be built into the mould 11 (shown in dotted outline) as the moulds 11 are constructed as shown in Fig. 27. The frames 112 and 113 create the door aperture and are left in place after the concrete forming the wall is set to enable mounting of doors. Some mould panels 12 and 13 may be left out as shown at 114 during the construction of the mould because they are within the aperture of the door frame 113.

Figs. 28 and 29 illustrate the use of a subfloor link assembly 115 under doors or openings which may be necessary to stop cracking of the concrete around doors due to movement of the adjacent walls relative to the floor slab 70 as allowed by the flexible connections to the starter bars of the floor slab as described above or by the sliding mounts 77. For installation of the subfloor link assembly 115, a trench 116 is moulded in the slab 70 across the location of the door frame 117 or opening using a suitable foam plastic insert in the slab 70 during moulding which later may be dissolved with suitable solvent resulting in forming the trench 116. A steel reinforcing rod 118 is inserted in the trench 116 prior to moulding of the walls. The rod 118 is bent at right angles at each end at 119 to protrude vertically into the wall mould cavity 29 at appropriate locations at either side of the door aperture or opening defined by the frame 117. Sheet metal cover plates 120 and 121 are positioned over the trench 116, the ends plates 121 having holes 122 to receive the vertically protruding ends 118' of the rod 118 to prevent concrete leaking into the trench 116 during moulding of the wall. The holes 122 in the plates 121 are sealed with suitable sealant 123. The protruding ends 118' of the rod 118 may be tied at each end to the adjacent steel reinforcing within the wall mould cavity 29 for example to the rods 75 at each side of the door frame 117. The impervious membrane 96 where used overlaps with the end cover plates 121.

After moulding of the wall, the cover plates 120 are screwed to the slab floor 70 via fixings at 124 to cover the exposed trench in the door aperture or opening, or

alternatively it may be cemented to the slab using suitable adhesive to render it flush. An appropriate small gap 125 is left between adjacent cover plates 120 and 121 to allow some movement of the walls next the door frame 117 relative to the slab 70 due to expansion.

Where concrete wall moulds 11 exceed certain length limits, expansion joints 126 as shown in Figs. 30 and 31 may be incorporated between adjacent wall mould sections. The expansion joint 126 includes complementary sections 127 and 128 typically formed of sheet metal, both sections 127 and 128 being of generally channel shaped form with the section 127 having a protuberance 129 that is a slide fit inside a complementary recess 130 in section 128. The sections 127 and 128 have side flanges 131 and 132 having slots 133 and 134 which are spaced apart a distance to align with connecting pins 28 between the mould 11. The sections 127 and 128 are assembled by sliding the flanges 131 and 132 between the mould panels 12 and 13 and the flanges 30 on the pins 28 before the wedges 39 (or nuts 47) are installed. The sections 127 and 128 may be left in place or removed after the concrete forming the wall has set. A flexible elastic medium 135 of suitable material is then placed between the sections 127 and 128 on opposite sides of the protrusion 129 and recess 130. The medium 135 may be of the liquid sealant type which cures over time. The steel reinforcing 136 within the moulds 11 extends close to the sections 127 and 128.

Fig. 32 shows an alternative expansion joint 137 which uses sections 138 and 139 similar to the expansion joint sections 127 and 128 however in this case the transverse dimensions of the sections 127 and 128 are such that the side flanges thereof locate about the pins 28 on the outside of the mould panels 12,13. This enables the sections 138 and 139 to be easily removed after the concrete forming the wall has set thereby forming a joint that comprises reinforced concrete alone and not including the sections 138 and 139. The sections 138 and 139 may therefore also be reused.

To stop the expansion joints 126 and/or 137 opening too far when flexible connections are provided between the wall reinforcing and the slab starter bars or where the reinforcing mounts 77 are used, expansion joint limiters 140 may be employed to interconnect adjacent wall sections on opposite sides of expansion joints 126 or 137 as shown in Fig. 33. The expansion joint limiters 140 are in the form of plates 141 which are secured between walls by suitable anchors 142 but which allow limited movement of the wall sections. Each plate has an enlarged aperture or slot 143 at one end to receive an

anchor 142 to allow movement of the anchor 142 relatively along the slot143 during relative movement between the adjacent wall sections. The limiters 140 may be located as desired and if necessary can be concealed above the soffit of a building.

For formation of a buttress wall, end sections 144 of generally channel shaped form as shown in Fig. 34 are secured to the ends of moulds 11, the end sections 144 being mounted in a similar manner to the sections 138 and 139 of Fig. 31 and being removable after moulding of the wall.

Where corners of a wall are to be constructed, inner and outer corner mould panels 145 and 146 are provided as shown in Figs. 35 and 36, each being of right-angle section form and typically being plastic extrusions and having opposite square edges. The main mould panels 12 and 13 for use with the corner mould panels 145 and146 also have end square edges adjacent the moulds 145 and 146 as described with reference to Figs. 2 and 3. The corner mould panels 145 and 146 are provided along opposite edges with holes 147 and 148 spaced for alignment with the holes 19 or 23 in the panels 12 and 13 for close receipt of the spigots 31 of the pins 28. Some of the holes 147 and 148 may be enlarged or slotted to allow for expansion of the plastic (or other material) of the corner mould panels145 and 146.

Bridging plates 149 (see Fig. 39) are used to connect the corner mould panels 145 and 146 to the main mould panels 12 and 13. The bridging plates 149 have holes 150 at the same pitch as the holes in the mould panels 11 and 12, 145 and 146. The pins 28 are used to interconnect the panels 12 and 13 with the corner mould panels 145 and 146 via the plates 149 located on the outside of the panels with support frames 48,49 or 60 used where required as shown. Corner steel reinforcing is provided at 151 within the corner to establish the required strength. After pouring of the concrete between the moulds 11 defined by the mould panels 12 and 13 and mould panels 145 and146, the pin spigots 31 are broken off with the wrench 38 as described previously after the concrete is set.

Referring now to Fig. 37, there is illustrated the moulding arrangement for a T-junction 152 which may be incorporated into a wall. Mould panels 12 and 13 with plain square edges are again required in order to present a flat edge to the T-junction moulds which comprise as also shown in Fig. 38 a rear planar mould panel 153 and a pair of right-angle mould panels 154, each of which also have plain square edges and are typically plastic extrusions but may be made by any method and be of any material and which

include along their opposite side edges spaced holes 155 and 156 for alignment with the holes 19 and 23 in the panels 12 and 13 and also the bridging panels 149. The mould panels 12 and 13 are joined in edge-to-edge relationship by bridging members 149 (see Fig.39) to the respective mould panels 153 and 154 through the aligned holes and by means of the pins 28 as illustrated. The bridging members 149 may be in various configurations depending upon the configurations of the mould panels 145 and 146 of Fig. 35 and of the mould panels 153 and 154. For example the mould panels 145, 146, 153 and 154 may be of thin wall construction and reinforced by webs thus requiring the bridging members 149 to be used with spacer spigots or have inwardly directed flanges to align the moulding faces of the mould panels 145, 146, 153 and 154 with those of the panels 12 and 13 to which they are joined.

Corner steel reinforcing 157 and straight reinforcing 158 is required within the tee junction 152 to establish the required strength. The rear mould panels 153 and angle mould panels 154 may be sized so that the rear mould panel 153 spans the same length as the standard length panels 12 and 13 to simplify construction of the opposite wall.

Figs. 40 to 42 illustrate the manner in which a wall may be moulded around windows. Upright support frames or posts 159 and 160 are located at spaced apart positions to define opposite sides of a window opening 161 and aligned with opposite moulds 11 defined by joined mould panels 12 and 13. Horizontal support frame assemblies 162 and 163 are located in the areas above and below the window to support the moulds. Window surround moulding panels 164 and 165 fit over the mould panels 12 and 13, support frames 162 and 163 and posts 159 and 160, being secured in position by the pins 28 as shown. For this purpose, side flanges of the panels 164 and 165 have slots 166 which align with and locate over the pins 28 joining respective panels 12 and 13. The frames 162 and 163 located above and below the window opening are fixed to the posts 159 and 160 via plates 167. The side moulding panels 165 have flanges 168 which are attached by screws 169 to the top and bottom window surround moulding panels 164. During moulding, horizontal braces (not shown) may be temporarily placed between the panels 165 to provide support and prevent collapse or bowing of the panels 165. Vertical braces may also be provided between for example the panels 164 to provide support where required. The braces may be held in position by screws or any other releasable fasteners.

Similar braces may be used in association with the door frames 112 or 113 or in any

other defined opening in a wall being moulded where required.

An alternative preferred window surround moulding panel 170 is shown in Figs. 43 and 44 which includes in this case a rebate 171 to locate the windows, a mitre 172 to enable mating with a mitre on the corresponding top and bottom window surround moulding panels and two individual apertured lugs 173 for securing the panels 170 to the corresponding top and bottom panels 164 (in place of the flange 168).

When the alternative mitred panels 170 are used, it is necessary to split the side panels into three parts 174, 175, and 176 as shown in Fig. 45 to enable removal of the panels. The central section 170 is required to include slots 160 to enable clamping by the pins 28. The window surround moulding panels may be metal or any suitable material.

In use the window surround moulding panels 164 and 165 (and/or 170) are left off until the concrete is poured to the level of the sill or lower window surround moulding panel. The window surround moulding panels are then assembled before the remainder of the concrete is poured.

Figs. 46 to 48 show the configuration of panels at corners of the window opening for example in the region F of Fig. 40 looking directly at the mould face. The corner window mould panels 178 and 179 are similar to panels 12 and 13 with plain edges as described with reference to Fig. 4 except that they have 45 degree mitres 180 on the flanges 181 and raised protuberances 182 with an edge perpendicular to the 45 degree mitres 180, the protuberances 182 being flush with the moulding surfaces 183 and 184. This allows the panels 178 and 179 to mate with an adjacent conventional panel 12 that is placed as indicated by the arrow 185 and locates on and overlaps the flanges 181. The corner window mould panels 178 and 179 may be distinguished and identified by colour and identification coding.

Fig. 49 illustrate a plastic conduit 185 that is placed at and spans the junction of the slab 70 and the wall cavity 186 at the location where cables and pipes pass. The conduit 185 also passes through the impervious membrane 96 (where used). The conduit 185 is sized larger than the cables or pipes to be passed therethrough. Flexible conduits 187 are attached to opposite ends of the plastic conduit 185 before moulding of the wall to enable carrying of the pipes or cables. The plastic conduit 185 will allow expansion movement of the wall 186 relative to the slab 70 by a shearing failure at the slab/wall junction however because this conduit 185 is oversize, the cable or piping within is not

damaged.

Referring now to Figs. 50 to 52, there is illustrated an alternative connecting pin assembly 188 for interconnecting panels 12 and 13 and moulds 11 defined thereby which may be used instead of the pins 28. The pin assembly 188 includes an outer elongated sleeve 189 which may typically be formed of a plastics material and may terminate at each end in flanges 190 which are equivalent to the flanges 30 of the pin 28 but the flanges 190 are not required to have the flats equivalent to flats 40 on the flanges 30 of pin 28. The sleeve 189 also includes internal dimples 191 intermediate the ends thereof for a purpose which will become apparent below. The pin assembly 188 also includes an elongated pin 192 which has a central portion 193 of a diameter substantially the same as the diameter of the sleeve bore 194 and a length greater than the sleeve 189 to define bosses 195 equivalent to the bosses 32 of the pins 28. The pins 192 are typically metal but may be of any suitable material. The pins 192 also include opposite spigot-like ends 196 of reduced diameter. If desired, the pin 192 may comprise an inner pin member which defines and is of the diameter of the spigot-like ends 196 and an outer tubular sleeve member which is of the outer diameter of the central portion 193 and bosses 195 located about the inner pin member, the outer tubular sleeve member defining the central portion 193 and bosses 195 of the pin assembly 188. This configuration of pin 192 may assist assembly of the panels 12 and 13 to form the wall mould. The spigot-like ends 196 have spaced slots 197 and 198 equivalent to the slots 33 and 34 of the pin ends 31. As referred to above however the pins 192 may have only one slot 197 at one end and the pair of slots 197 and 198 at the opposite end or single slots 197 only at opposite ends. Alternatively the spigot-like ends 196 may be threaded as in the embodiment of Figs 12 and 13.

For assembling moulds panels 12 and 13 to form moulds 11, the pins 192 are inserted into the bores 194 of the sleeves 189 and are held frictionally by the dimples 191 so that ends of the pins 192 project equally from opposite ends of the sleeve 189. The pin assemblies 188 are then used in the same manner as the pins 28 with the flanges 190 abutting the inner faces 14 of the moulds 11 to set the spacing between the moulds 11 and the spigot-like ends 196 and bosses 195 projecting through aligned holes 19 and 23 in the panels 12 and 13. The spigot-like ends 196 are also passed through the support frames 48, 49 or 60 where used. The spigot-like ends 196 and bosses 195 also pass through the flexible bushes 42 which also seal the ends of the sleeve 189. The pin assemblies 188 are

then secured to the panels 12 and 13 (and the support frames where used) by the wedges 39 where the slots 197 and 198 are used or by nuts where the spigot-like ends 196 are threaded. The concrete moulding process is then undertaken as before and after the concrete has cured, the pins 192 are withdrawn lengthwise from the sleeves 189, the latter remaining embedded within the concrete of the moulded wall. The ends of the sleeve 189 which have been sealed by the bushes 42 may then be closed by bungs 199 which may be formed of plastics or any other material. As shown the bungs 199 preferably have a flanged head 200 and the sleeve bore is countersunk at each end as at 201 to receive the heads 200 of the bungs 199 such that the heads 200 of the bungs 199 can locate within the countersunk portions 201 to be flush with the sleeve flanges 190.

The sleeve 189 may additionally be provided with a pair of spaced flanges 202 arranged centrally of the sleeve 189 to locate reinforcing rods (shown in dotted outline) which may be tied to the sleeve 189. The above described configuration arrangement of pin assembly allows the pins 192 to be reused. The flanges 202 however are not essential and other means may be provided for locating the reinforcing.

Referring now to Figs. 53 and 54, there is illustrated an alternative method of moulding around windows using the moulding apparatus and method of the invention similar to the manner of installing door frames as described with reference to Fig. 27. In this method, a rectangular perimeter frame 203 defined by moulding panels of exact width to fit in the cavity 29 between the moulds 11 defined by mould panels 12 and 13 (shown in dotted outline) may be installed between the moulds 11 as the moulds 11 are constructed therefore creating the window aperture 204. Some mould panels 12 and 13 may be omitted in the window aperture area 204 to allow access. On the bottom sill-defining horizontal member 205 of the frame 203, access holes 206 are provided which allow filling of the mould cavity 29 up to the level of the frame member 205. Cover plates 207 are provided to close the holes 206 during moulding, the cover plates 207 carrying blanking plates 208 which are of complementary shape to the holes 206 being secured to the cover plates 207 by screws 209 or other releasable fasteners. The cover plates 207 with attached blanking plates 208 are secured to the bottom frame member 205 by further screws 210. On completion of the moulding, the cover plates 207 are removed by removing the screws 210 and at the same time, the screws 209 are removed leaving the blanking plates 208 behind to fill the access holes 206. The sill-defining

member 205 may also be provided with a series of spaced air expulsion holes 211 to allow escape of air as concrete is filled the mould cavity 29 beneath the sill-defining member 205. The holes 211 may be plugged with screws after concrete has filled the cavity up to the member 205. Similar air expulsion holes may be provided in the lower moulding panel 164 (see Fig. 40). The frame 203 may be made collapsible to enable it to be removed if removal is required. Normally however, the frame 203 remains in situ within the moulded wall.

Many other shapes may also be moulded into the walls by the use of appropriate moulding members of inserts interposed between the opposite moulds 11. For example, a curved moulding member 212 (shown in dotted outline in Fig. 27) may be use in combination with a door moulding frame 113 to form an arch. Similarly, to form gables as shown in Fig. 55, angled moulding members 213 may be provided between the moulds 11 (shown in dotted outline) with the mould members 12 and 13 along the line of the gable being of stepped inwardly to the peak of the gables. The moulding members 213 may comprise single moulding members or alternatively a series of aligned moulding members. Of course the moulding members 213 may be of any profile such as a curved profile to form a curved shape at the upper side of a wall.

Referring now to Fig. 56 and 57, there is illustrated an alternative method and apparatus for erecting moulds for moulding walls of concrete or other settable material and using mould panels 12 and 13 as described above for forming opposite moulds 11 and in which like-components to those used in the above described method and apparatus have been given like numerals. In this case, spaced apart support frames 60 (only two of which are shown) are initially erected on a slab or other foundation and in longitudinal alignment with each other. Upper and lower horizontal members 203 and 204 are then secured between the support frames 60 and a series of vertical frame members 205 erected between the upper and lower frame members 203 and 204 such as to create a grid.

Opposite ends of the horizontal members 203 and 204 are provided with brackets 206 which are apertured for alignment with apertures in the vertical frame members 61 to receive ends of the interconnecting pins, in this case the spigot-like ends 196 of the pins 192 of the pins assemblies 188, the sleeves 189 having been removed. This connects the members 203 and 204 to the vertical members 205. The vertical frame

members 205 are provided with similar brackets 207 for connection at upper and lower ends to the frame members 203 and 204 by means of the pins 192. The vertical frame members 61 of the support frames 60 and the frame members 205 are provided with apertures which are spaced apart the same distance as the apertures in the panels 12 and 13 and further pins 192 are positioned in these apertures to extend outwardly from the members 61 and 205.

Panels 12 and 13 of the first mould 11 are then positioned alternatively in the correct sequence over the pins and pushed up against the frame members 61 203, 204 and 205. The flexible material 27 may be provided about the periphery of alternate panels prior to assembly where required. As stated above, the flexible material 27 may be of many different configurations and material and are suitably formed to enable the panels 12 and 13 to be moved laterally into position as illustrated and effect a seal between the panels 12 and 13. Pins 192 are also positioned in the central slots in the overlapping panels 12 and 13. The wedge members 39 may be located in the slots 198 of the pins at or prior to this time and thereafter the sleeves 189 are slid over the pins 192 and hard up against the panels 12 and 13. Reinforcing may then be placed in position being supported on the sleeves 189 and panels 12 and 13 of the opposite mould 11 may then be positioned so that the apertures 19 and 23 are aligned with and can receive the projecting pin ends 196. The wedge members 39 may then be placed in the slots 197 or 198 to hold the panels 12 and 13 in position and define the cavity 29 between the moulds 11 ready to accept concrete or other settable material. If desired upper and lower horizontal straps 208 may be placed over the pin ends 196 on the outside of the panels 12 and 13 to provide additional support during the concrete pour to prevent wall bowing. After the pour, the wedge members 39 are removed from the pin ends 196, the supporting grid disassembled and panels 12 and 13 removed along with the pins 192 leaving the sleeves 189 within the formed wall. Ends of the sleeves 189 may then be plugged by the bungs 199. Of course in the above arrangement, pins 28 of the configuration previously described may be used in lieu of the pin assemblies 188.

The use of a grid formed by the members 61, 203,204 and 205 fixes the position of the connecting pins 192 (or 28) and thus the position of the reinforcing supported by the pins whilst the panels 12 and 13 supported on the pins are capable of a limited degree of longitudinal movement.

Conduits may be laid within the moulds before the concrete is poured to receive electrical cables and plumbing. Foam plastic blocks may be mounted on the mould faces to create mounting cavities for switches, power points etc. The blocks may be chemically dissolved after the wall is moulded. Frames and posts may be located using straight edges during construction of moulds. Mould panels may be deleted as required at desired locations eg. at openings.

Whilst the reinforcing used between the moulds is shown to be a plurality of interconnected reinforcing rods, the reinforcing may comprise a reinforcing mesh. Further whilst the wall is described as being constructed upon a floor, it may be constructed upon any other suitable foundation such as footings.

Claims

1. A method of constructing a wall of concrete or other settable material, said method including the steps of

providing first and second moulds, each said mould comprising a plurality of mould panels, each said mould panel having a moulding surface,

arranging said mould panels relative to each other such that peripheral portions of adjacent said mould panels overlap and said moulding surfaces are substantially coplanar to define mould faces of said first and second moulds,

providing interconnecting means for holding said moulds at a desired spacing to define a mould cavity therebetween, said interconnecting means extending through said overlapping portions of said mould panels to interconnect at least adjacent side by side mould panels in each said mould,

depositing concrete or other settable material into said mould cavity to form said wall, and

removing said moulds after curing of said concrete or settable material.

2. The method of claim 1 wherein said interconnection means interconnects said moulds and mould panels in such a manner as to prevent movement of said mould faces transversely away from each other but permitting limited movement of said panels longitudinally relative to each other.

3. A method according to claim 2 and including the step of providing flexible or elastic means between mating edges of the mould panels to accommodate said limited longitudinal movement thereof.

4. A method according to claim 2 or claim 3 wherein said wall is constructed upon an existing floor and wherein said method includes the step of providing an impervious membrane or layer between said floor and moulds to permit a constructed wall to move relative to said floor.

5. A method according to any one of claims 1 to 4 and including the step of providing reinforcing between said moulds prior to depositing of the concrete or other settable material.

6. A method according to any one of claims 1 to 5 wherein said interconnecting means comprise elongated connectors and wherein said panels include apertures in said peripheral portions, and wherein opposite ends of said elongated connectors are passed through aligned said apertures in said overlapping portions of said panels to interconnect said panels and said moulds.

7. A method according to claim 6 wherein at least some of said apertures carry flexible bushes or inserts and wherein said ends of said connectors are passed through said flexible bushes or inserts.

8. A method according to claim 6 wherein said ends of said elongated connectors are removed after curing of said concrete or other settable material.

9. Apparatus for forming walls of concrete or other settable material, said apparatus including first and second moulds, each said mould having a mould face defined by a plurality of mould panels, each said mould panel having a moulding surface, the peripheral portions of adjacent said mould panels overlapping each other and said moulding surfaces being substantially coplanar to define mould faces of said first and second moulds, and interconnecting means holding said moulds at a desired spacing to define a mould cavity therebetween, said interconnecting means extending through said overlapping peripheral portions of said mould panels to interconnect at least adjacent side by side said mould panels

10. Apparatus according to claim 9 wherein said panels are interconnected by said interconnecting means in such as manner as to permit limited movement of said mould panels relative to each other in a direction parallel to said mould face.

11. Apparatus according to claim 10 and including flexible or elastic means between

mating edges of said mould panels to accommodate said limited movement between said mould panels.

12. Apparatus according to any one of claims 9 to 11 wherein one or both said moulds are supported in an upright position by at least one support post or frame, said mould or moulds being connected to said at least one support post or frame by said interconnecting means.

13. Apparatus according to claim 12 wherein a plurality of support posts or frames are provided and adjacent support posts or frames are interconnected by elongated spanning members which hold said posts or frames at a fixed spacing relative to each other.

14. Apparatus according to any one of claims 9 to 13 wherein said peripheral portions of said mould panels are provided with a plurality of apertures therethrough, apertures in adjacent said panels being aligned when said peripheral portions thereof overlap and wherein said interconnecting means comprise elongated connectors which extend into opposite aligned apertures in opposite mould panels.

15. Apparatus according to claim 14 wherein said elongated connectors are provided with flanges which abut the mould faces to hold said moulds at a desired spacing.

16. Apparatus according to claim 15 wherein said elongated connectors have ends which project through said aligned apertures and wherein stop means engaged with said pin ends hold said panels to said elongated connectors.

17. Apparatus according to claim 16 wherein said pin ends include enlarged diameter bosses adjacent said flanges for location in said apertures, said bosses being of a length slightly greater than the width of joined panels.

18. Apparatus according to claim 17 wherein said ends of said elongated connectors are separable from the remainder of the elongated connectors adjacent said flanges to leave a surface substantially flush with the outer surface of the wall being moulded.

19. Apparatus according to claim 18 wherein said elongated connectors are necked or undercut adjacent said flanges to facilitate separation of said ends

20. Apparatus according to claim 14 wherein said each said connector comprise an elongated sleeve having a said flange at opposite ends thereof and an elongated pin removably received within said sleeve, said pin projecting beyond said flanges to define said ends of said connectors.

21. Apparatus according to claim 20 and including bungs receivable in opposite ends of said sleeve upon removal of said elongate pin to close said ends of said sleeve adjacent to said flanges.

22. Apparatus according to claim 20 wherein said elongated pin comprises an inner pin member and an outer tubular sleeve member surrounding said inner pin member and being of a length greater than said elongated sleeves to define bosses for location in said aligned apertures.

23. Apparatus according to any one of claims 16 to 22 wherein said ends include at least one slot for receiving a stop member therethrough defining said stop means.

24. Apparatus according to claim 23 wherein said stop member is of a wedge-shaped or tapering configuration for wedging into said slot.

25. Apparatus according to claim 23 wherein a pair of spaced slots are provided in at least one end to locate said stop members at different positions in said ends.

26. Apparatus according to any one of claims 16 to 18 wherein said ends have one or more flats for cooperation with a socket of a tool and whereby the tool may be twisted or rotated to effect separation of said ends of said elongated connectors.

27. Apparatus according to any one of claims 16 to 22 wherein said ends are threaded

and wherein said stop means comprise nuts threadably engageable with said ends.

28. Apparatus according to any one of claims 15 to 27 wherein said stop means when engaged with said ends allow said panels to move longitudinally of said mould faces and transversely of said connectors.

29. Apparatus according to any one of claims 14 to 28 wherein at least some of said apertures in said panels are provided with a flexible bush or insert to receive said ends of said elongated connectors.

30. Apparatus according to any one of claims 14 to 29 wherein said panels include outer flanges which overlap and wherein said apertures in the panels are provided in said flanges, said apertures in adjacent panels being aligned when the flanges overlap each other.

31. Apparatus according to any one of claims 9 to 30 wherein said panels are substantially rectangular and wherein the corners of the flanges of at least some of the panels are truncated at 45 degrees to allow cooperation which adjacent diagonally arranged panels.

32. Apparatus according to any one of claims 9 to 30 wherein said panels are of a curved configuration for forming moulds of curved configuration to form curved walls.

33. Apparatus according to any one of claims 9 to 32 and including reinforcing between said moulds, said reinforcing including a plurality of vertical reinforcing members.

34. Apparatus according to claim 33 wherein said vertical reinforcing members are secured to upwardly projecting starter bars and wherein resilient sleeves are provided over the starter bars to allow for independent expansion movement of the concrete wall.

35. Apparatus according to claim 33 wherein said wall is erected on a floor slab and

wherein mounts are provided in said floor slab for supporting said vertical reinforcing members, said mounts allowing limited movement of said reinforcing and thus said wall relative to said floor slab.

36. Apparatus according to claim 35 wherein each said mount comprises a base member which is anchored in the slab and a coupling member which is supported for limited horizontal and vertical movement relative to the base member.

37. Apparatus according to claim 36 wherein said coupling member includes a plate carrying a socket for engagement by a vertical reinforcing member and wherein said base member captures said plate.

38. Apparatus according to claim 37 wherein said base member includes first and second plates located above and below said coupling plate.

39. Apparatus according to claim 37 or claim 38 wherein said socket projects above said slab and a cover seals the socket to said base member to prevent ingress of concrete or other settable material into said mount.

40. Apparatus according to any one of claims 37 to 39 wherein resilient pads are provided to limit movement of said coupling member.

41. Apparatus according to any one of claims 9 to 40 wherein said wall is formed directly on a floor slab.

42. Apparatus according to claim 41 and including external clamp means for holding said moulds to a floor.

43. Apparatus according to claims 9 to 41 wherein said wall is erected on a floor slab and including an impervious membrane or layer which is applied said floor slab prior to pouring of the concrete or other settable material to allow the formed wall to expand independently of the slab.

44. Apparatus according to claim 41 or claim 43 and including a door frame for defining a door opening through a said wall, said door frame being located between opposite said moulds prior to pouring of concrete or other settable material into said mould cavity.

45. Apparatus according to claim 44 and including a reinforcing link located within said slab and extending between said door opening and into said mould cavity on opposite sides of said door opening.

46. Apparatus according to any one of claims 9 to 45 and including first and second aligned frames positioned adjacent opposite said moulds and there being provided infill panels extending between said first and second frames and defining a window opening.

47. Apparatus according to claim 46 wherein diagonally arranged mould panels defining corners of said widow opening are mitred to mate at two mutually perpendicular edges, said panels having mating flanges for overlapping by a further mould panel which defines with said corner mould panels part of a said mould face.

48. Apparatus according to any one of claims 9 to 45 and including a frame for defining a window opening, said frame being located between opposite side moulds prior to pouring of concrete or other settable material into said mould cavity.

49. Apparatus according to claim 48 wherein said frame includes a sill defining member, said sill defining member having one or more closable air expulsion openings therein to permit expulsion of air during moulding.

50 Apparatus according to claim 49 wherein said sill defining member is provided with one or more access openings and there being provided means for closing said openings.

51. Apparatus according to any one of claims 9 to 50 and including an expansion joint

incorporated into said moulds to separate said moulds into adjacent mould sections, said expansion joint including complementary end members secured to adjacent mould sections and having cooperable configurations to maintain said mould sections in longitudinal alignment.

52. Apparatus according to claim 51 and including a resiliently compressible material between said end members.

53. Apparatus according to claim 51 or 52 and including means spanning said adjacent mould sections at said expansion joint for limiting longitudinal movement of said mould sections away from each other.

54. Apparatus according to claim 9 and including an end member secured to a free end of said moulds to define a moulded said wall as a buttress wall.

55. Apparatus according to claim 9 and including a pair of angled corner mould panels joined to and aligned with the respective said moulds by bridging members to define a corner of a moulded wall.

56. Apparatus according to claim 9 and including T-junction defining mould panels comprising a first planar mould panel and a pair of opposite right angled mould panels, said planar mould panel being aligned with and secured to one said mould and said angled mould panels being aligned with and secured to the other said mould to define walls extending at right angles to each other.

57. Apparatus according to claim 41 or claim 43 and including a conduit spanning the junction between said floor slab and wall cavity, opposite ends of said conduit being connected to flexible conduits for carrying cables or pipes.

58. Apparatus according to any one of claims 9 to 57 and including one or more further curved moulding members or inserts adapted for location between said moulds for forming an arch in a formed said wall.

59. Apparatus according to any one of claims 9 to 58 and including one or more further moulding members or inserts adapted for location between said moulds to form a gable in a formed said wall.

60. A method of erecting a mould assembly for constructing a wall of concrete or other settable material, said method including the steps of providing first and second moulds, each said mould comprising a plurality of mould panels, each said mould panel having a moulding surface,

arranging said mould panels relative to each other such that peripheral portions of adjacent said mould panels overlap and said moulding surfaces are substantially coplanar to define mould faces of said first and second moulds,

providing interconnecting means for holding said moulds at a desired spacing to define a mould cavity therebetween, said interconnecting means extending through said overlapping portions of said mould panels to interconnect at least adjacent side by side mould panels in each said mould.

61. The method of claim 60 wherein said interconnection means interconnects said moulds and mould panels in such a manner as to prevent movement of said mould faces transversely away from each other but permitting limited movement of said panels longitudinally relative to each other.

62. A method according to claim 61 and including the step of providing flexible or elastic means between mating edges of the mould panels to accommodate said limited longitudinal movement thereof.

63. A method according to any one of claims 60 to 62 wherein said interconnecting means comprise elongated connectors and wherein said overlapping peripheral portions of said panels include aligned apertures, and wherein opposite ends of said elongated connectors are passed through said aligned said apertures to interconnect said panels and said moulds.

64. A method according to claim 63 and including the step of providing at least one support frame for supporting one or both said moulds in an upright position, and wherein at least one said end of a said elongated connector is passed through an aperture in said support frame to secure said mould to said support frames.

65. A method of erecting a mould assembly for constructing a wall of concrete or other settable material, said method including the steps of arranging at least one pair of mould panels in a desired spacing to define a mould cavity therebetween, said mould panels having apertures therein, the apertures in the respective mould panels being transversely aligned with each other, providing flexible elements within said apertures, providing interconnecting means between said mould panels for holding said mould panels at said desired spacing, said interconnecting means extending through said flexible elements and apertures in said spaced mould panels, whereby to permit limited longitudinal movement of said mould panels relative to said interconnecting means.

66. A method according to claim 65 and including the step of arranging a plurality of mould panels in an edge-to-edge mating relationship and providing flexible or elastic means between mating edges of the mould panels to accommodate said limited longitudinal movement thereof.

67. A method according to claim 66 and including the step of providing a plurality of upright support means for supporting said mould panels in an upright attitude, and securing said interconnecting means to said support means on at least one side of said mould panels.

68. A method according to claim 67 and including the step of providing elongated spanning members for spanning said upright support means and interconnecting said elongated members to said upright support members to form a support grid for said panels.

69. A method according to claim 68 and including the step of securing a plurality of elongated upright members to said upper and lower elongated spanning members between said upright support means.

70. A method according to claim 69 and including the step of securing said elongated spanning members to said upright support means and said elongated upright members to said upper and lower spanning members with said interconnecting means.

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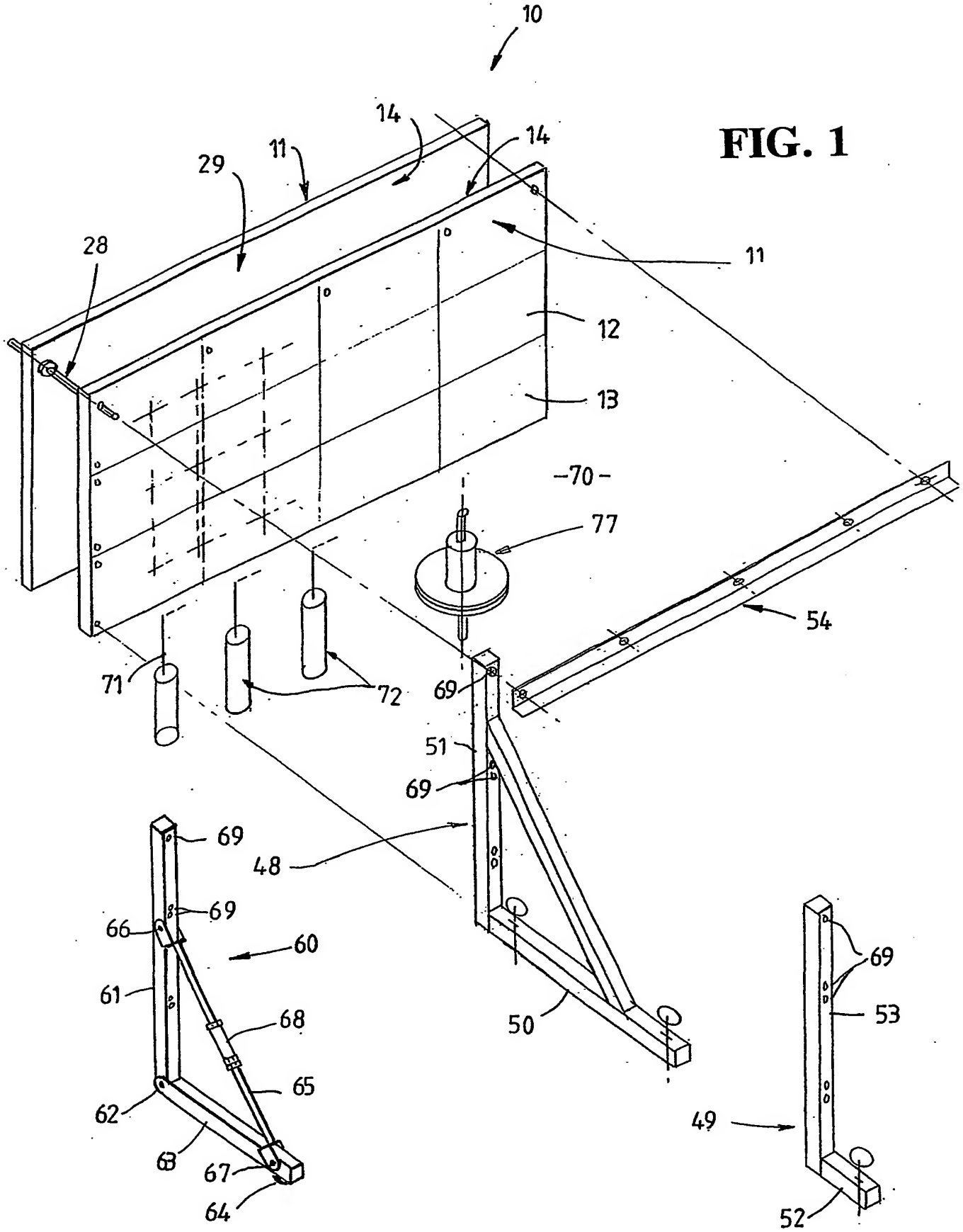
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FIG. 1

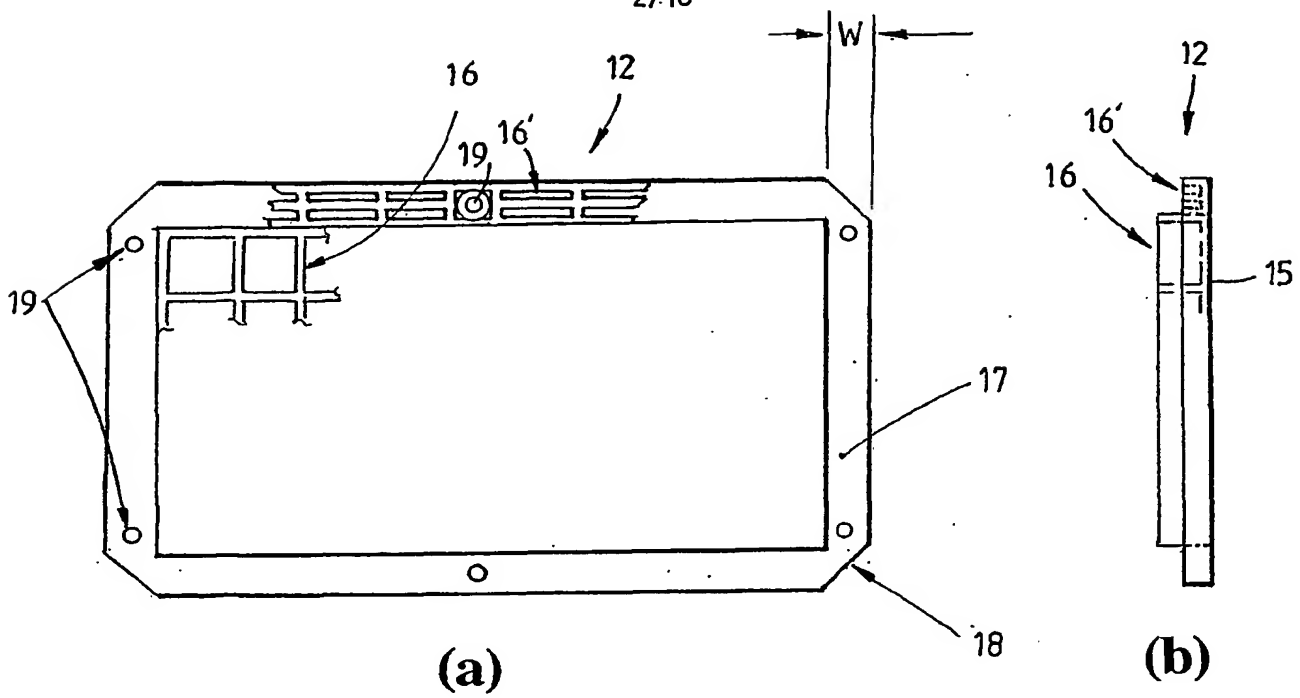

FIG. 2

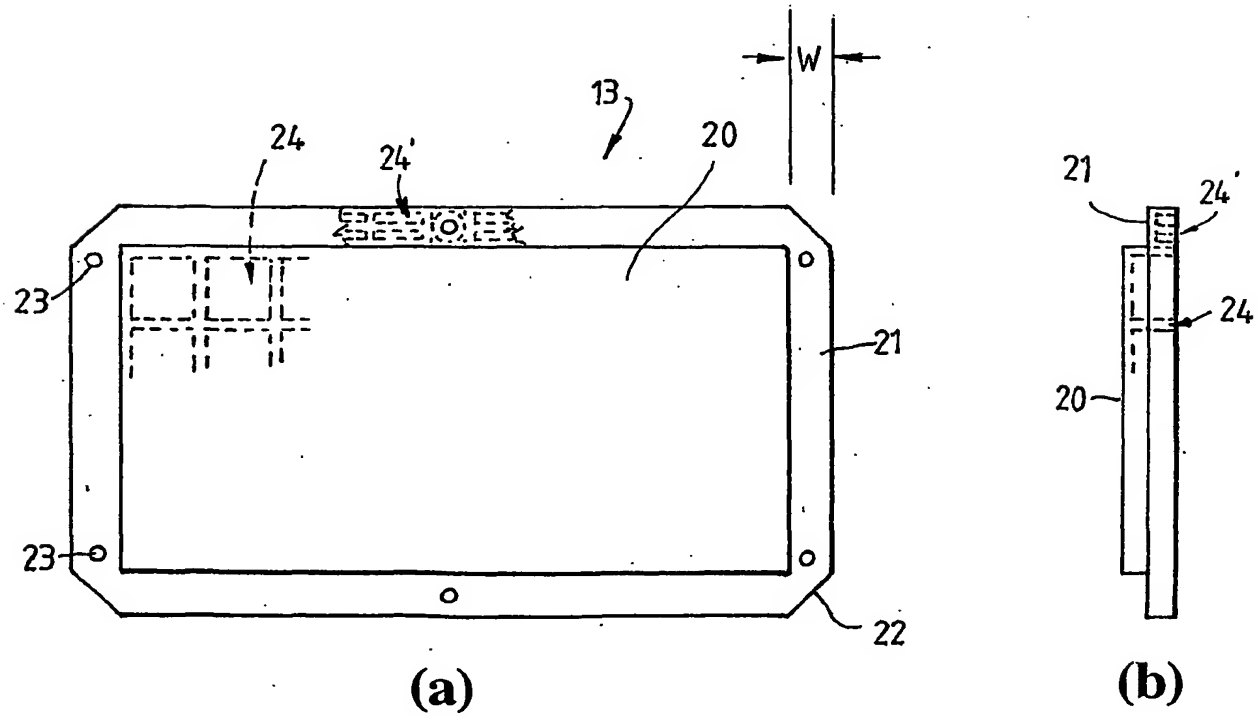

FIG. 3

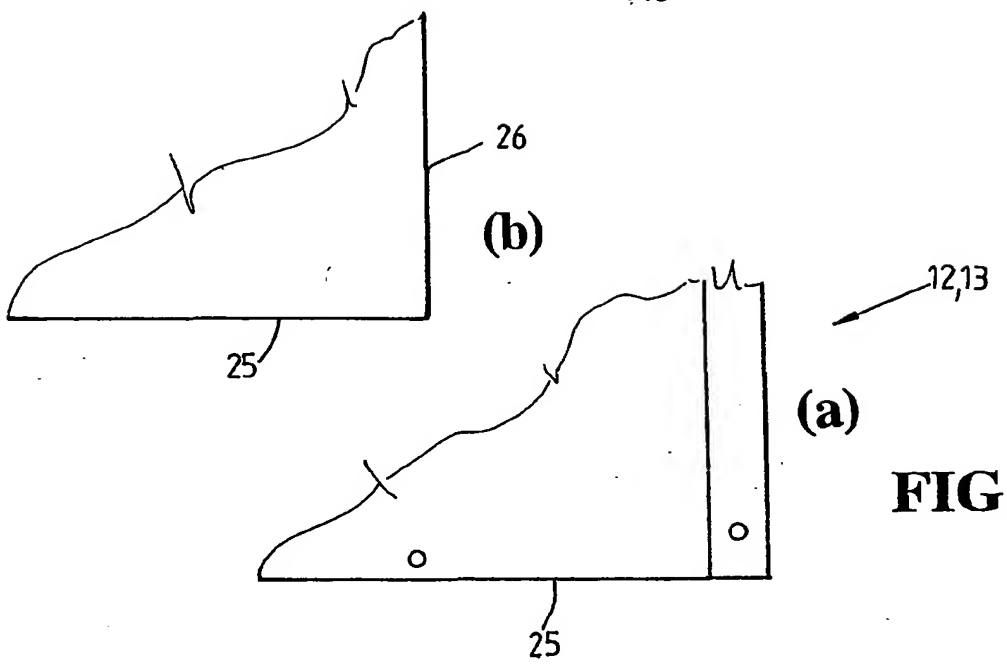

FIG. 4

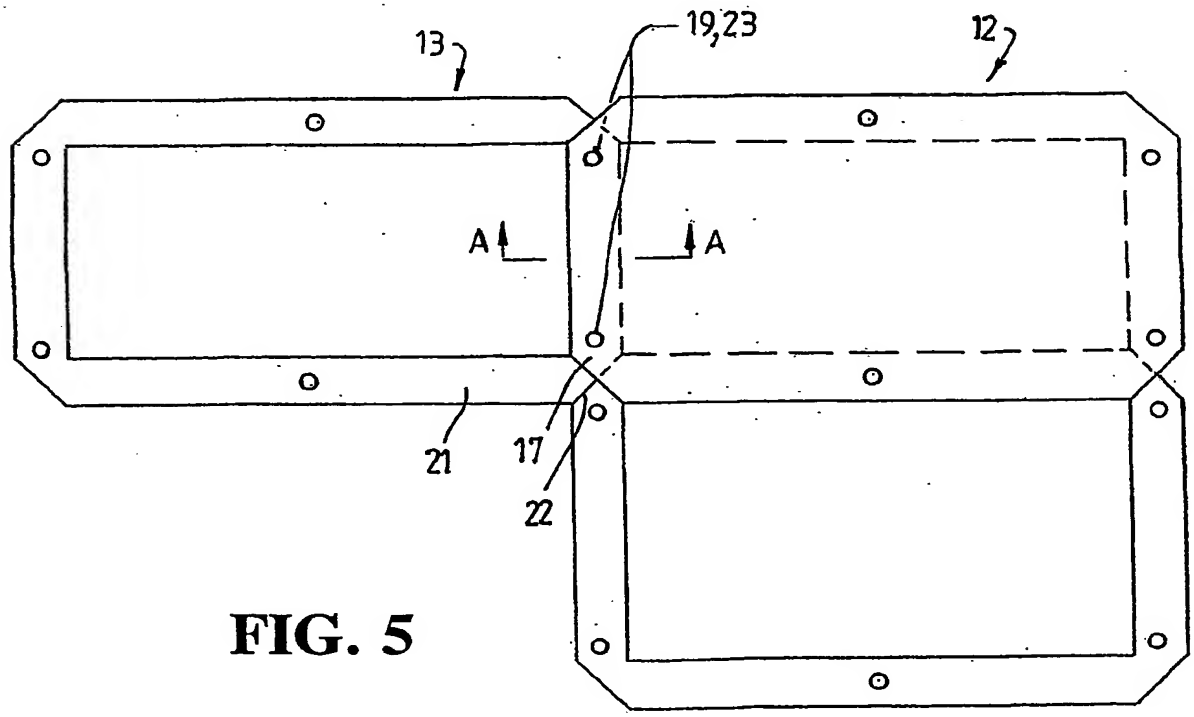

FIG. 5

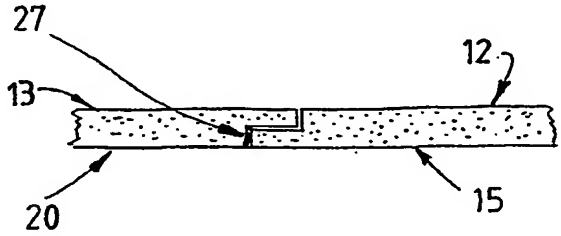

FIG. 6

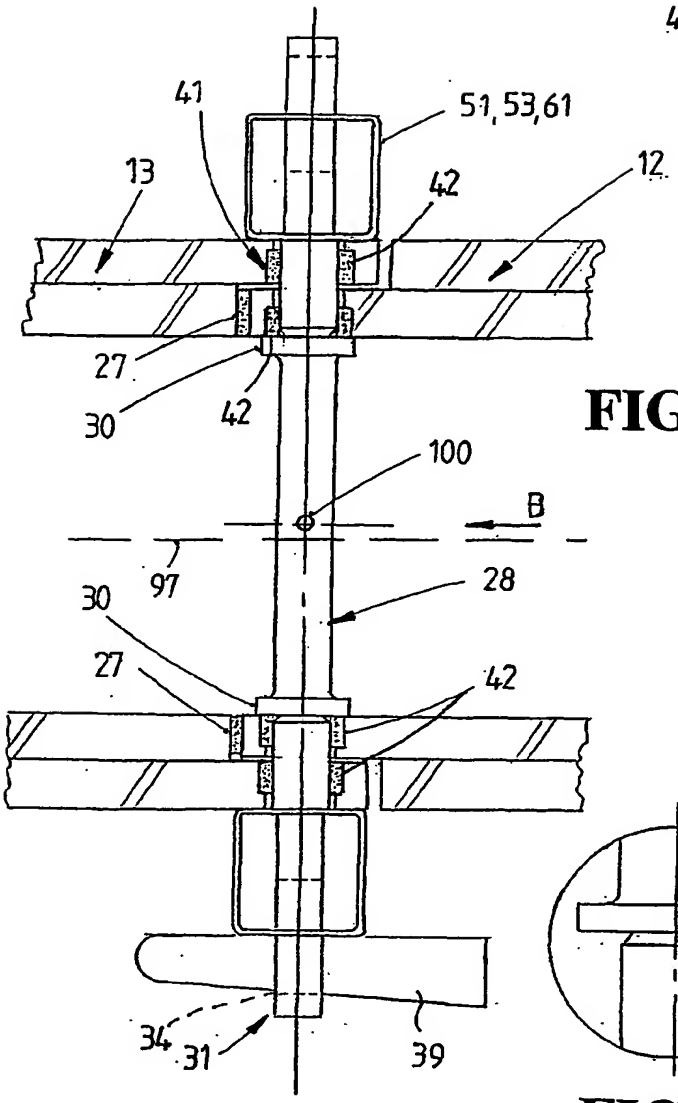

FIG. 7

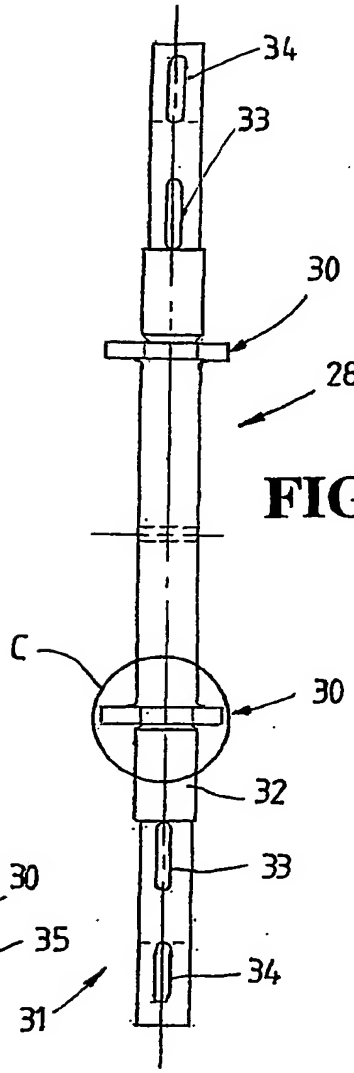

FIG. 8

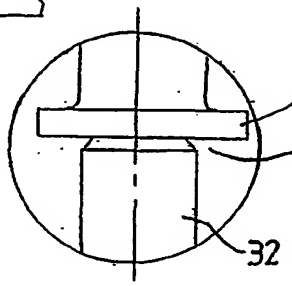

FIG. 10

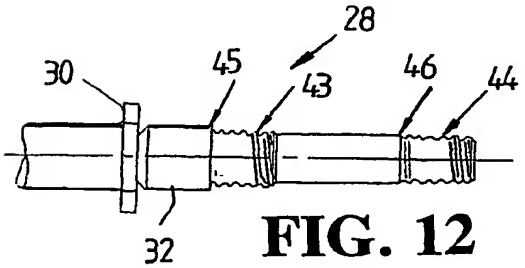

FIG. 12

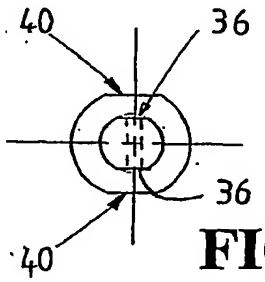

FIG. 9

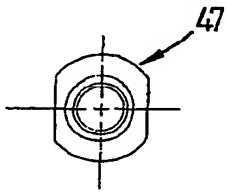

FIG. 13

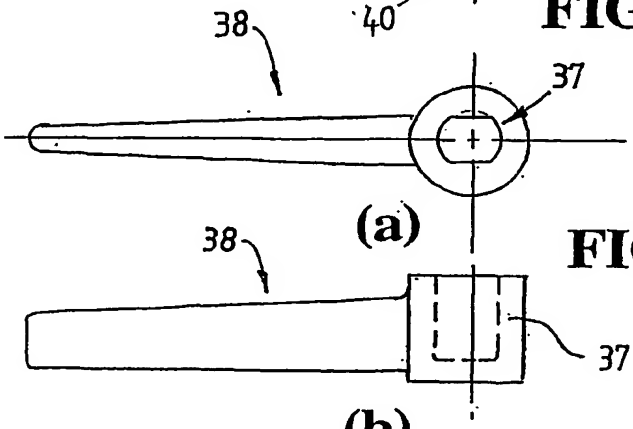

FIG. 11

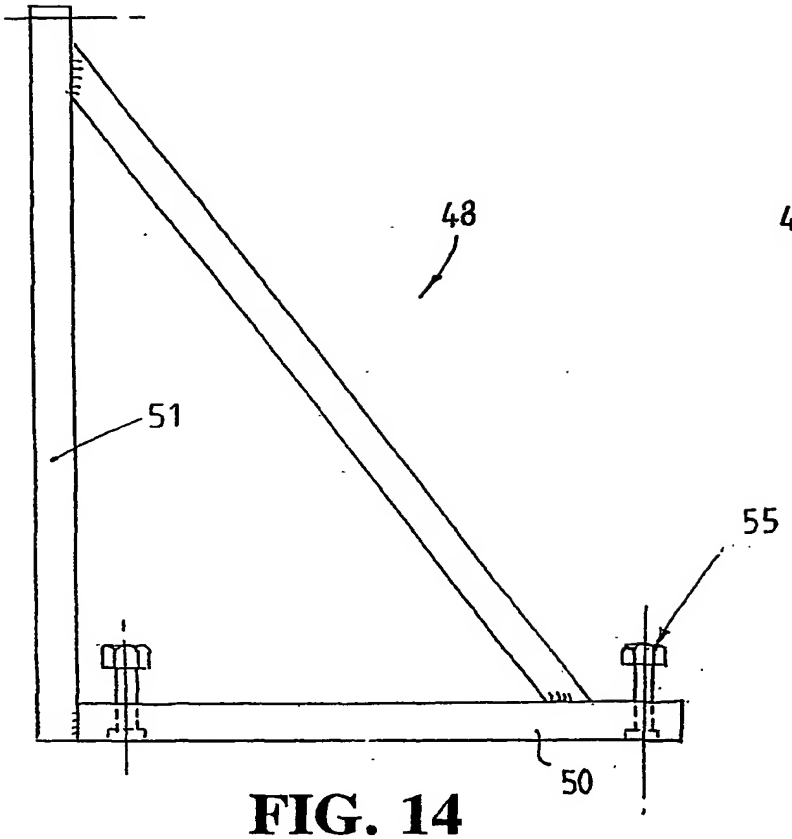

FIG. 14

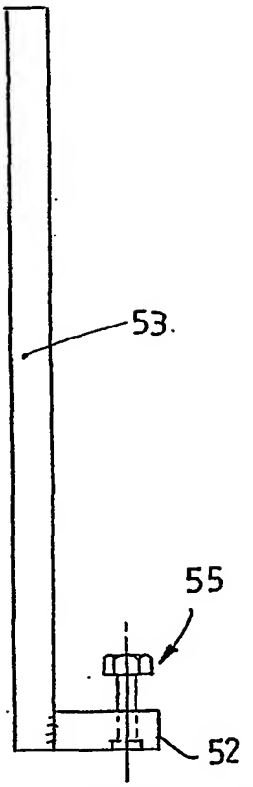

FIG. 15

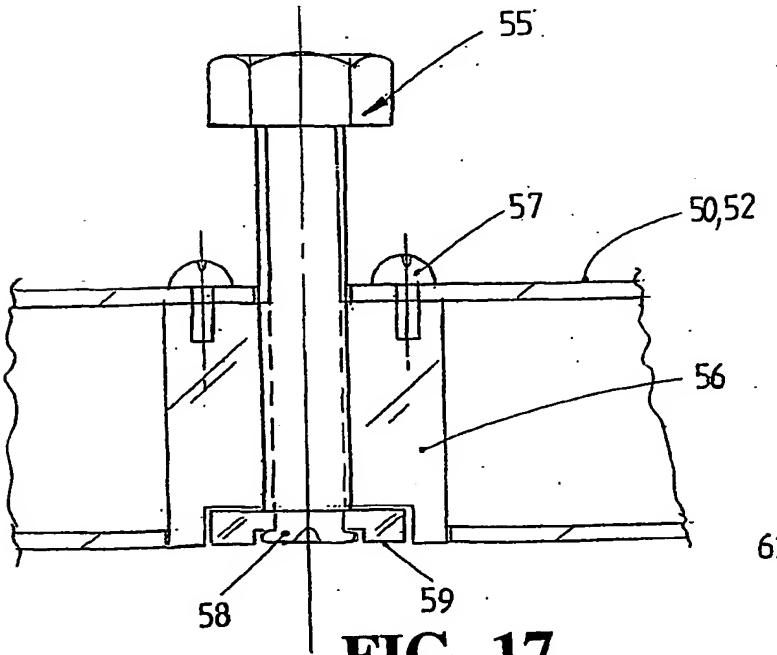

FIG. 17

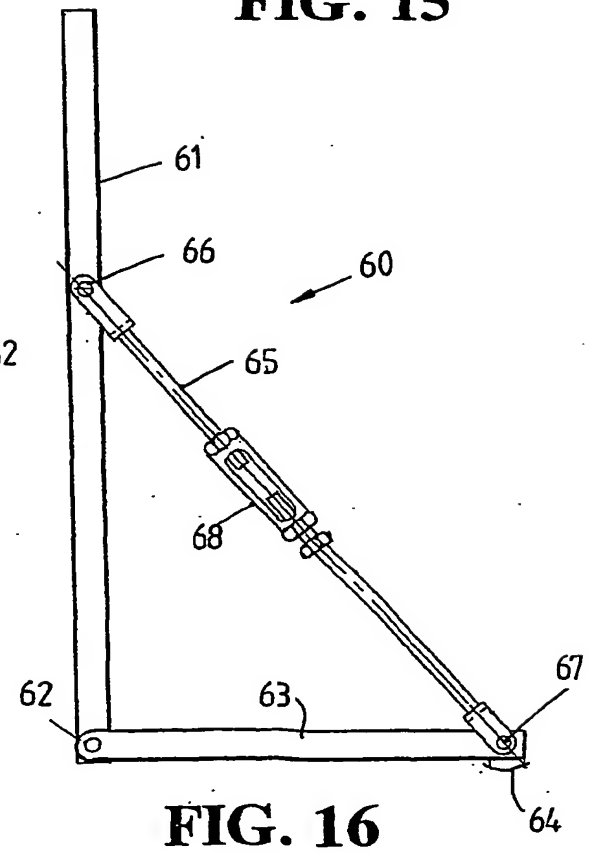

FIG. 16

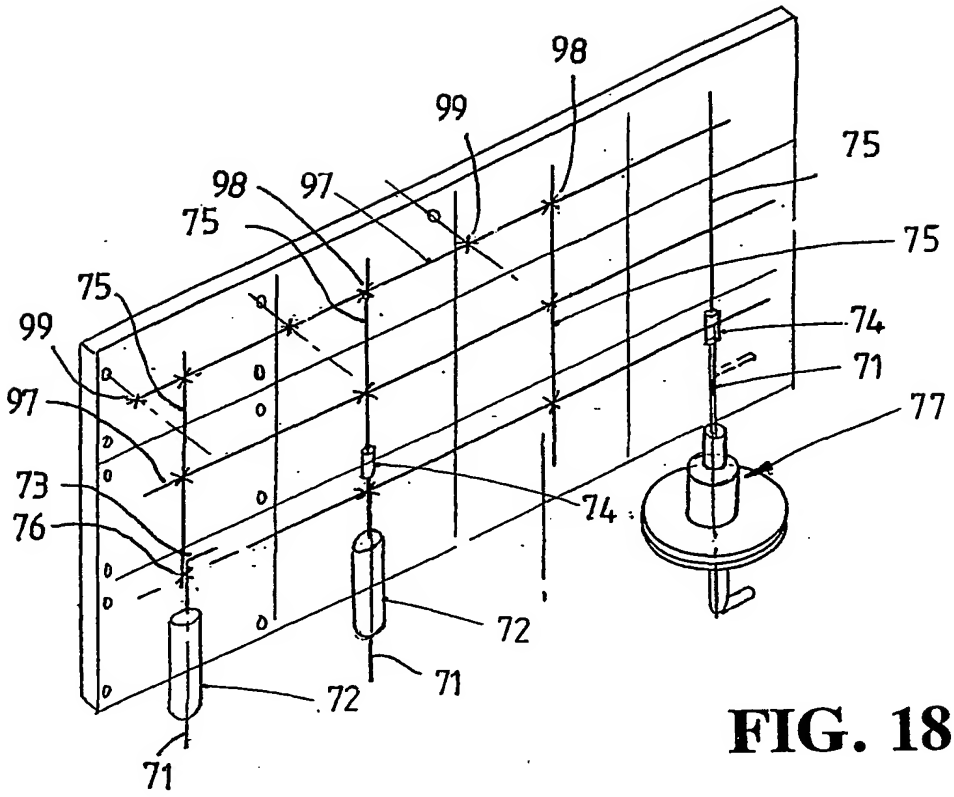
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FIG. 18

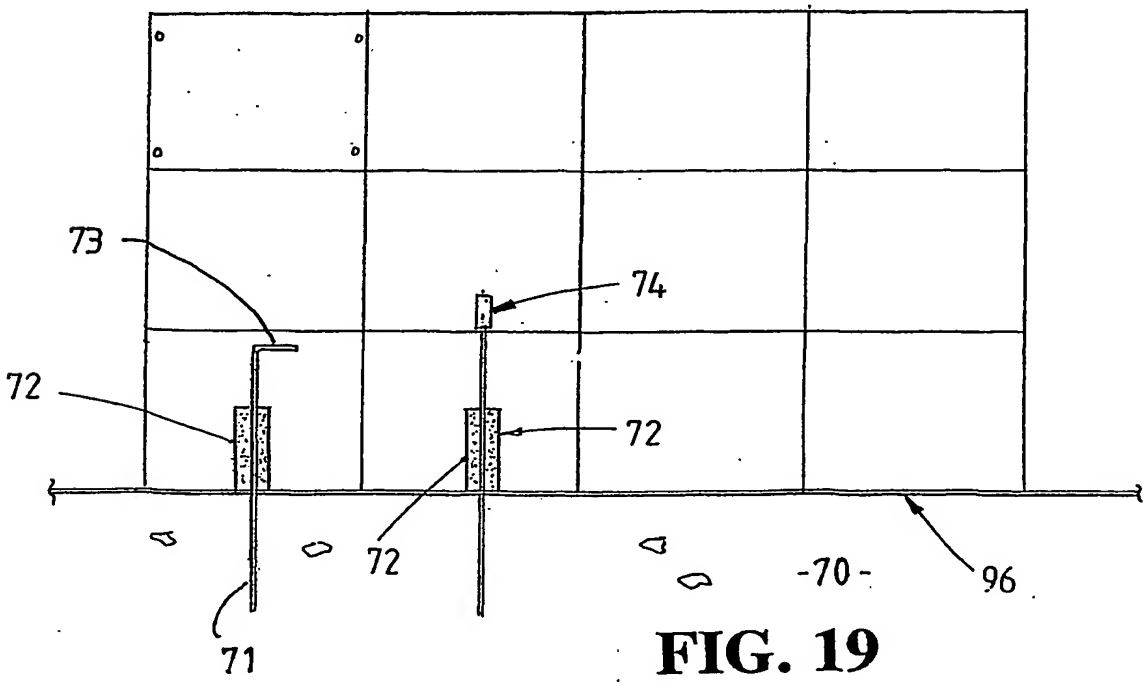
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FIG. 19

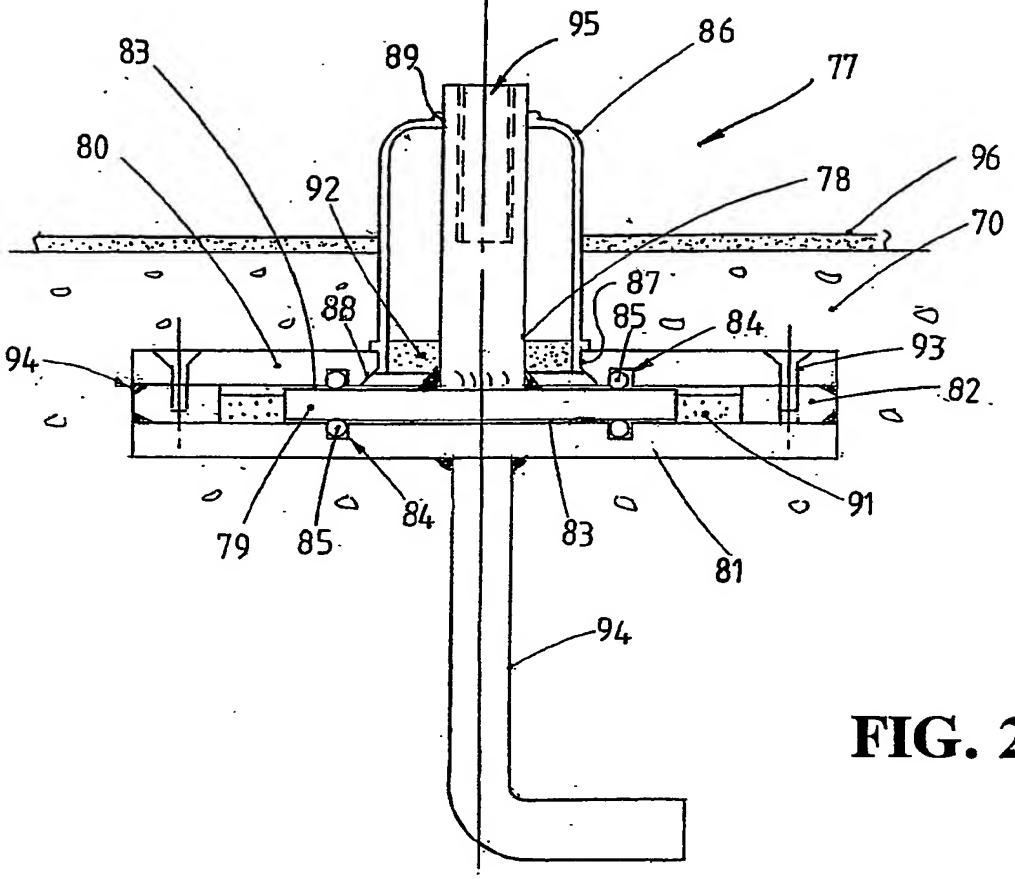


FIG. 20

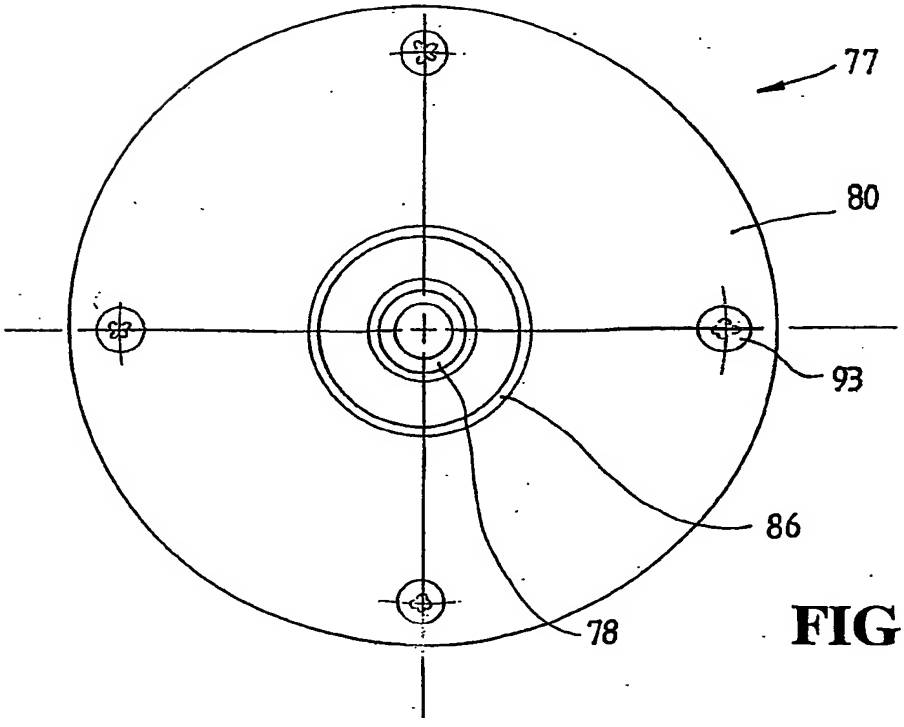


FIG. 21

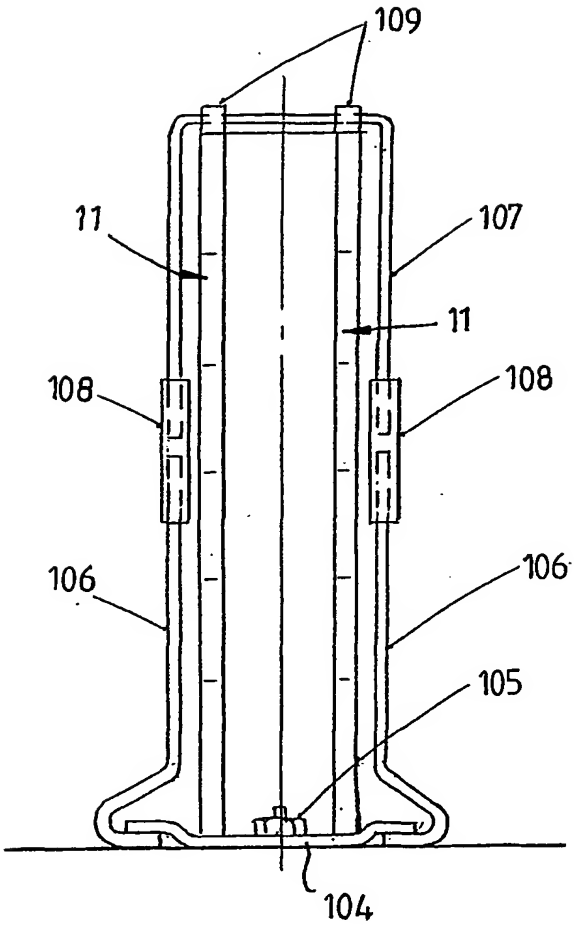


FIG. 24

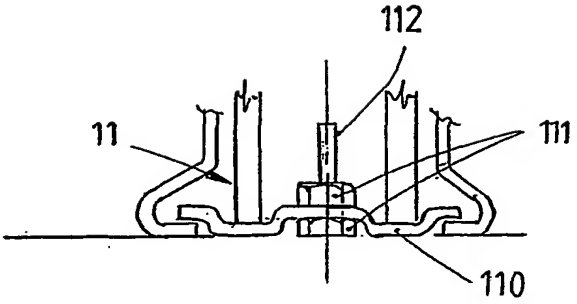


FIG. 26

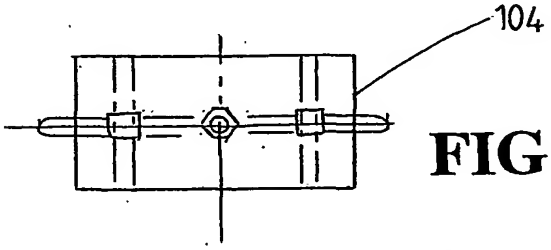


FIG. 25

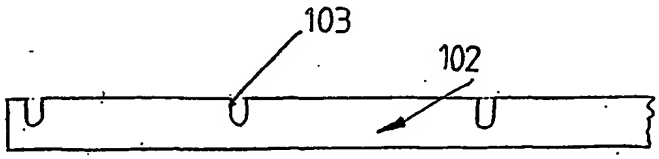


FIG. 23

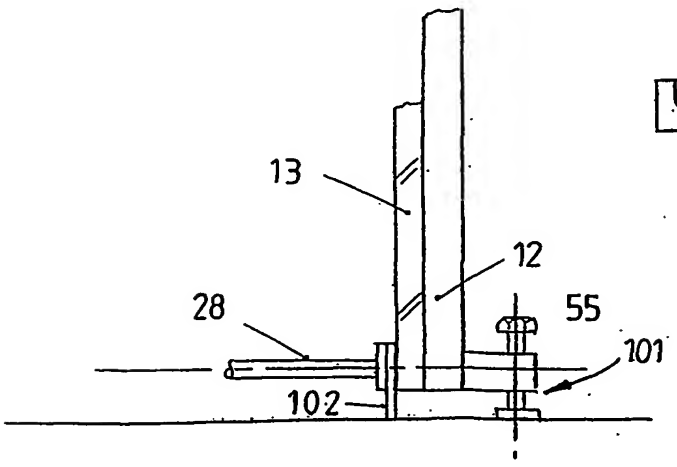


FIG. 22

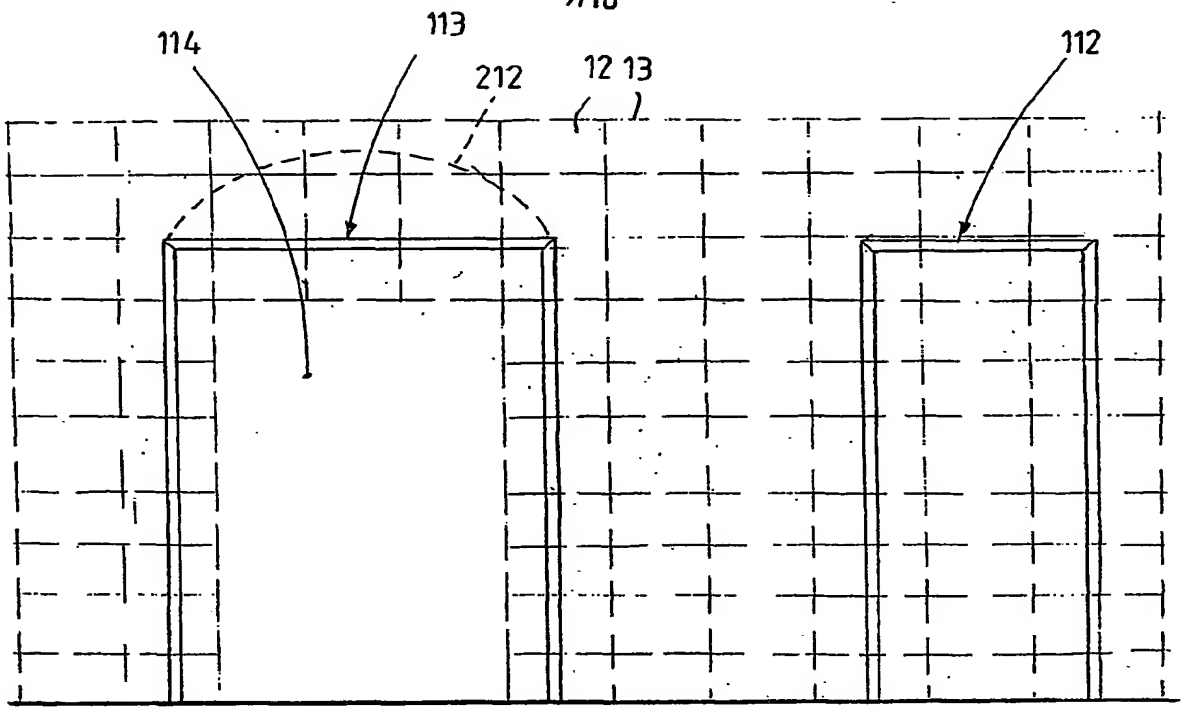


FIG. 27

FIG. 28

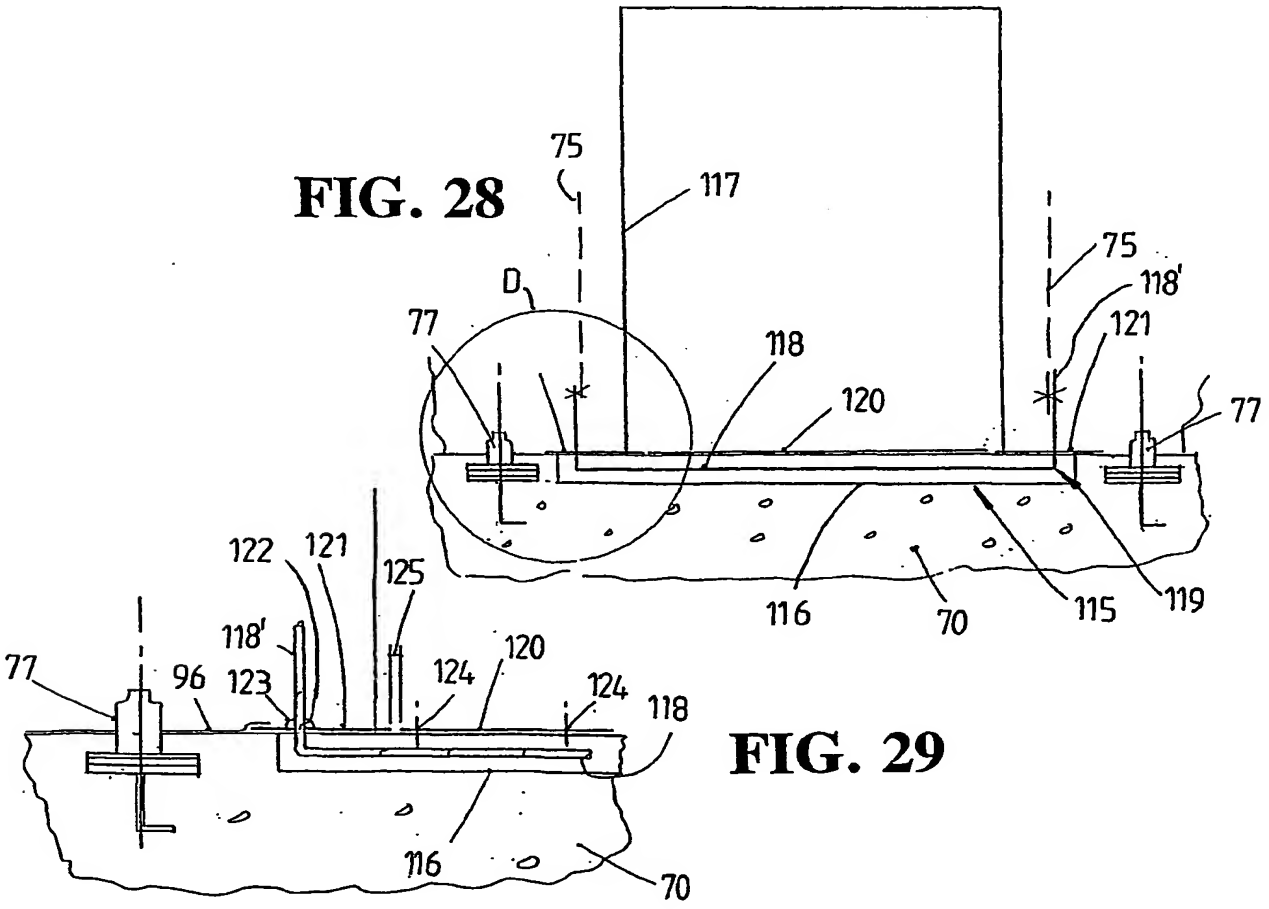


FIG. 29

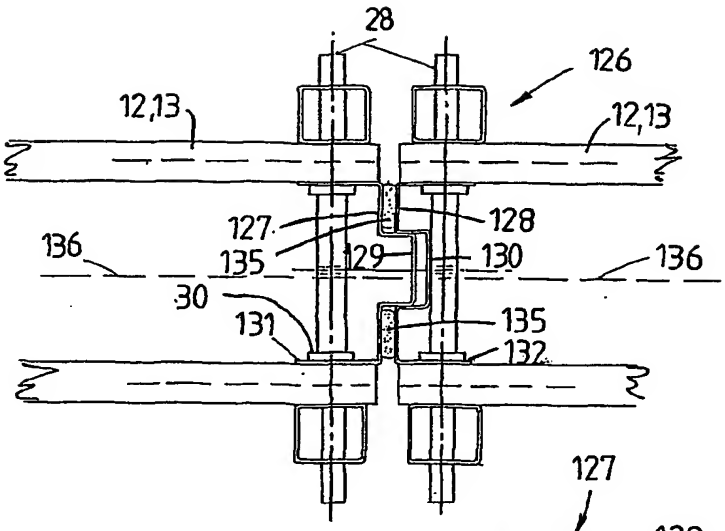
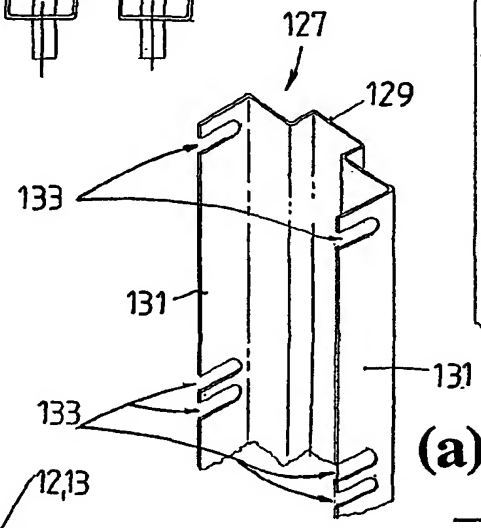
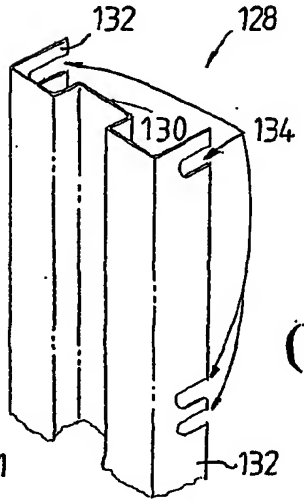


FIG. 30



(a)



(b)

FIG. 31

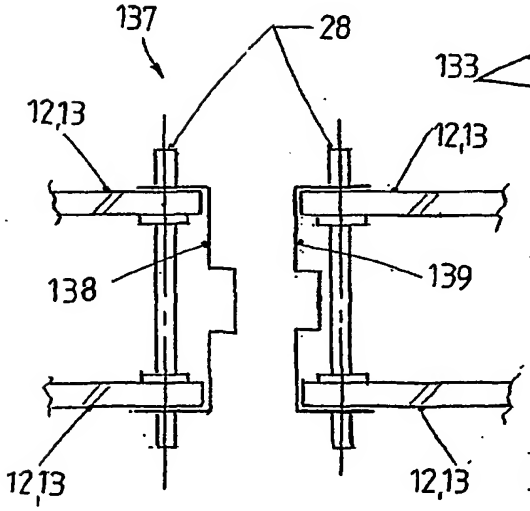


FIG. 32

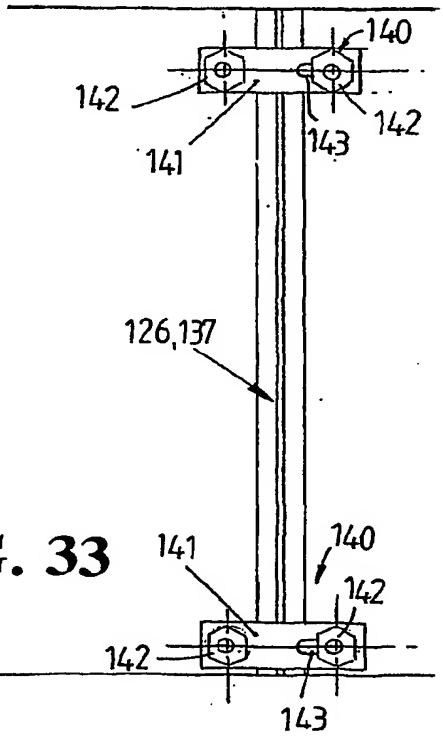


FIG. 33

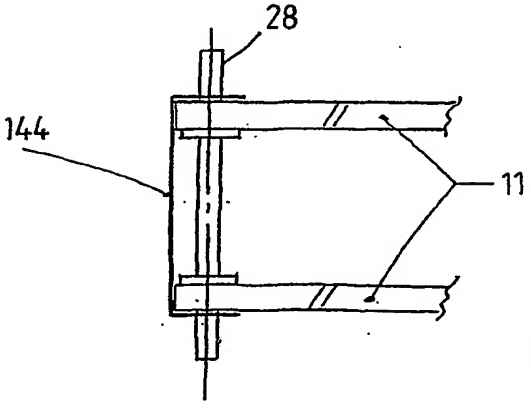


FIG. 34

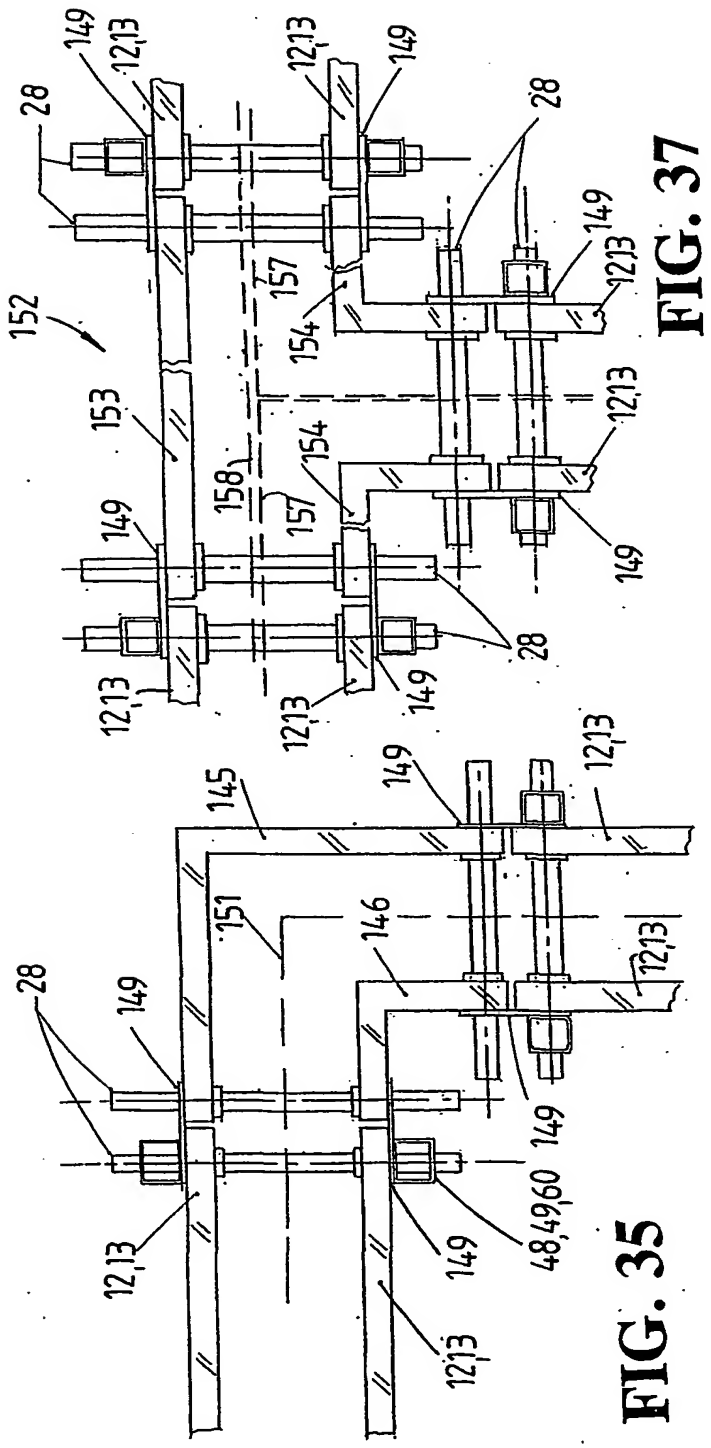


FIG. 37

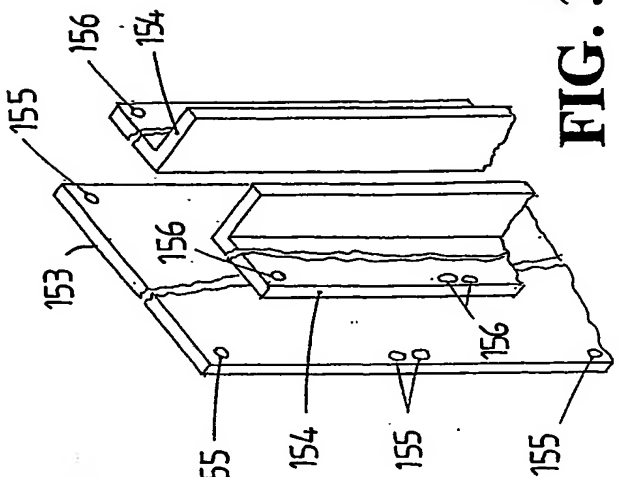


FIG. 38

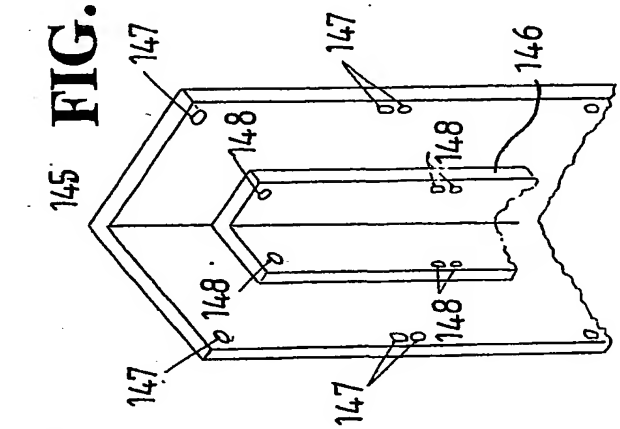


FIG. 36

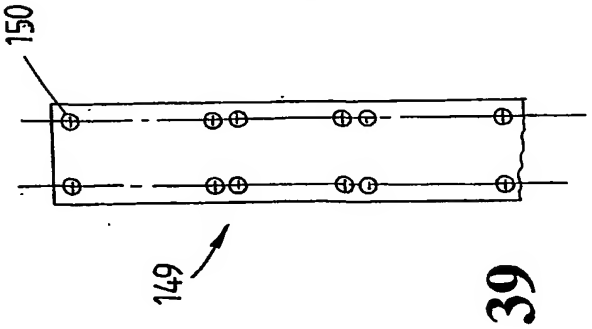


FIG. 39

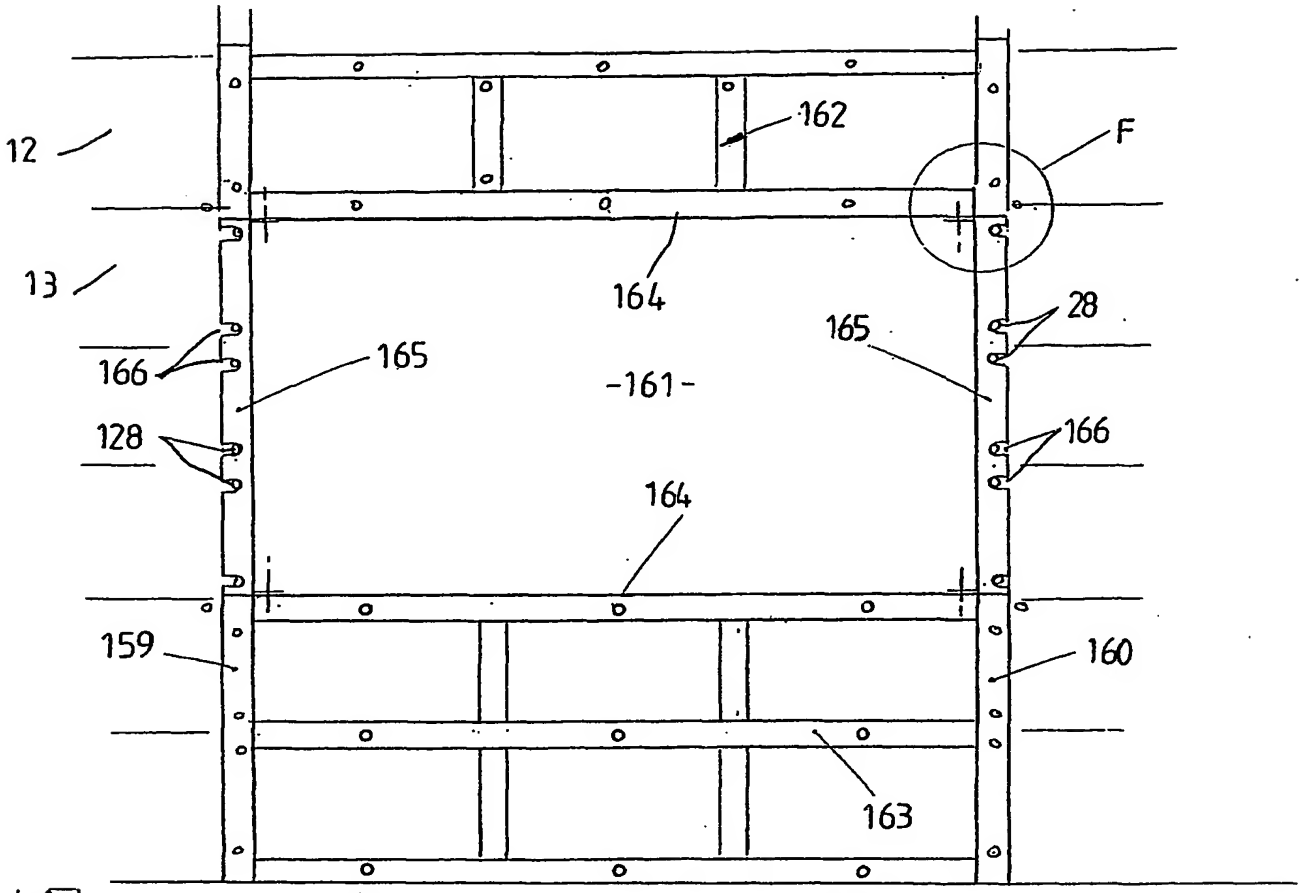


FIG. 40

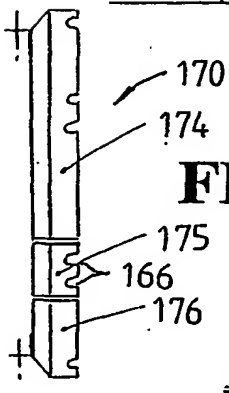


FIG. 45

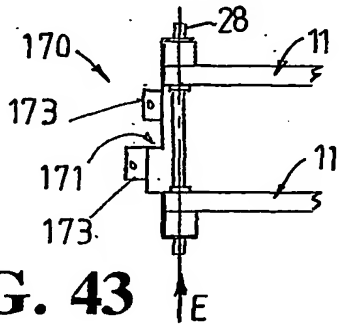


FIG. 43

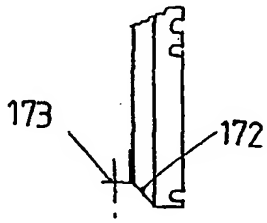


FIG. 44

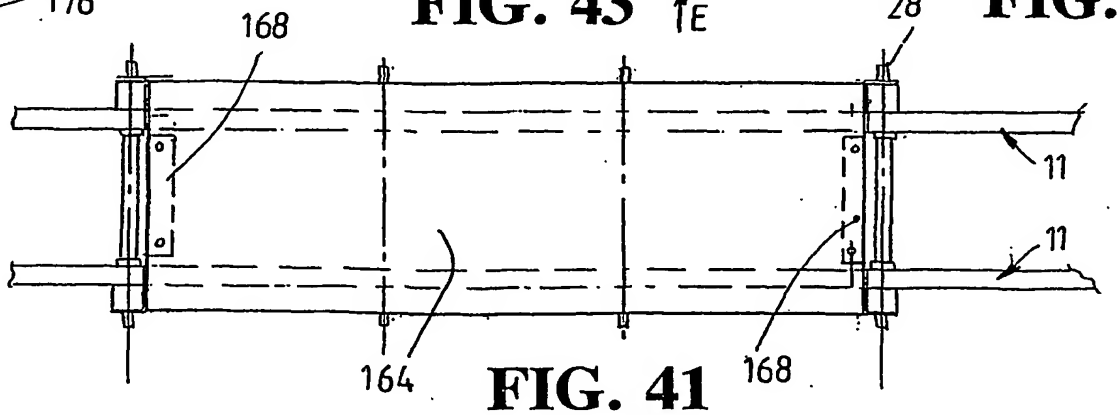


FIG. 41

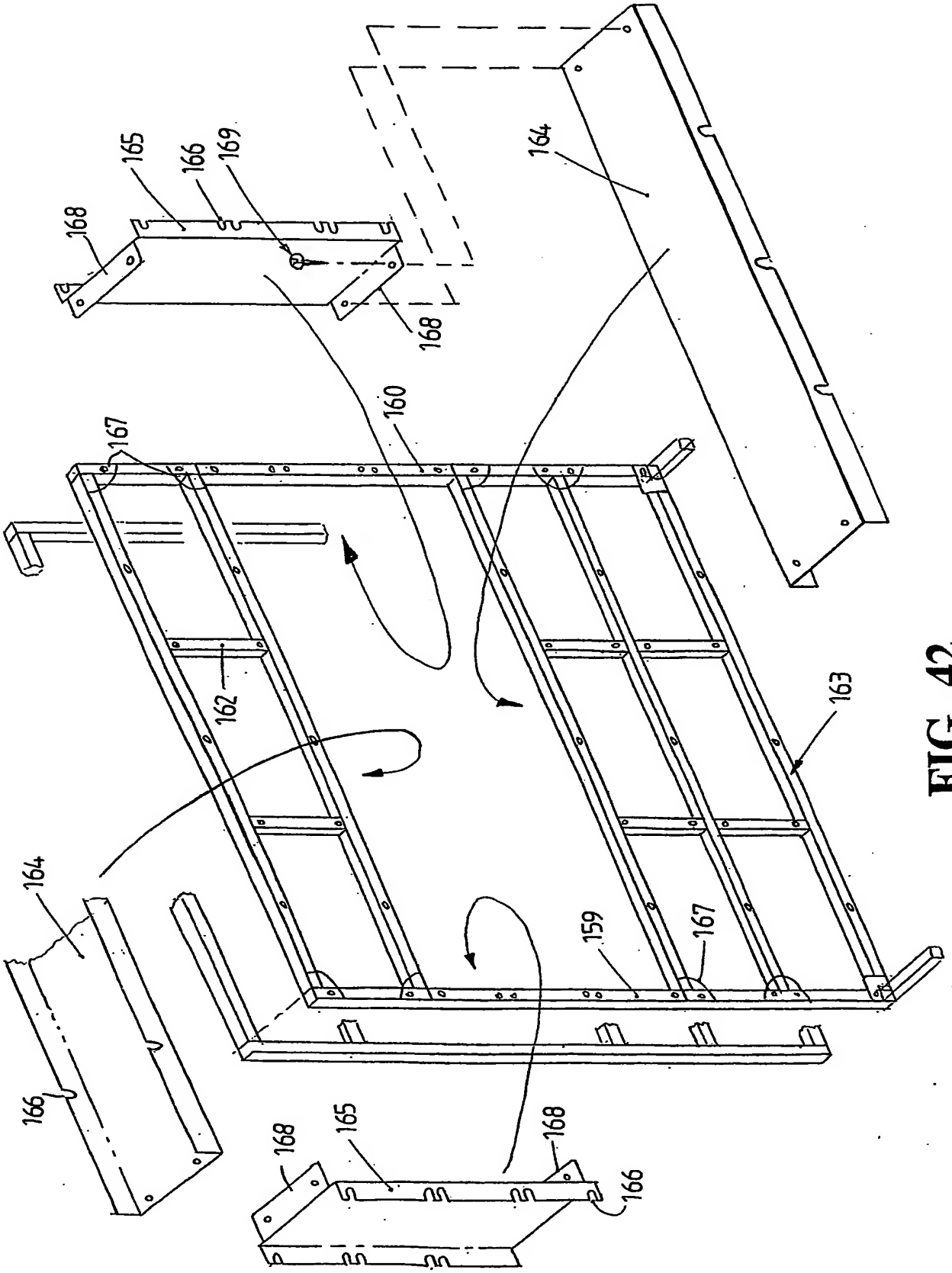


FIG. 42

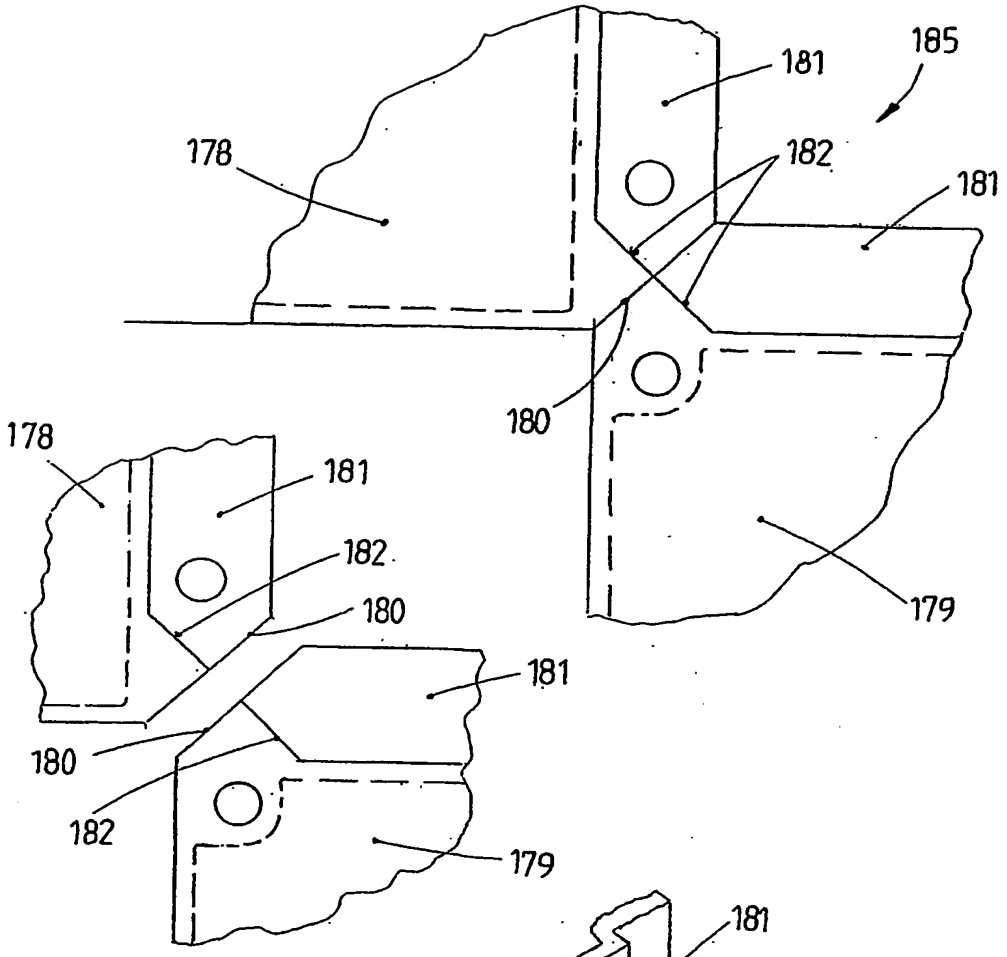


FIG. 46

FIG. 47

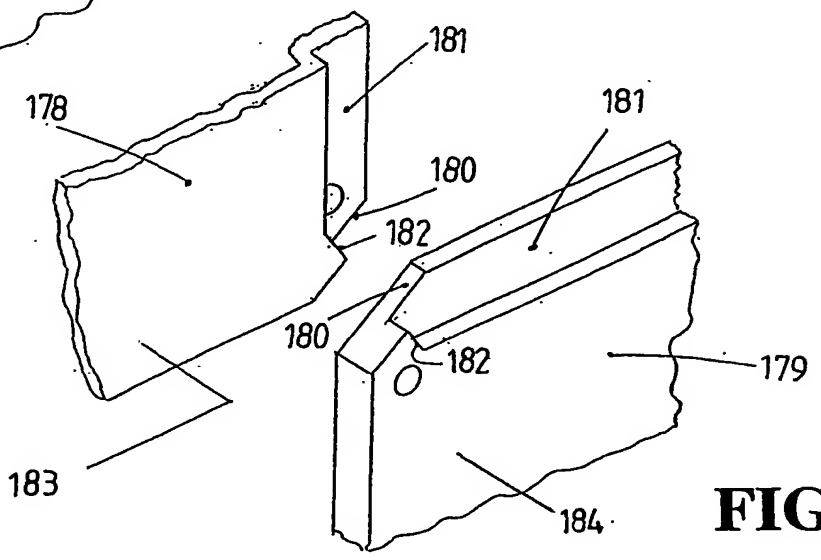


FIG. 48

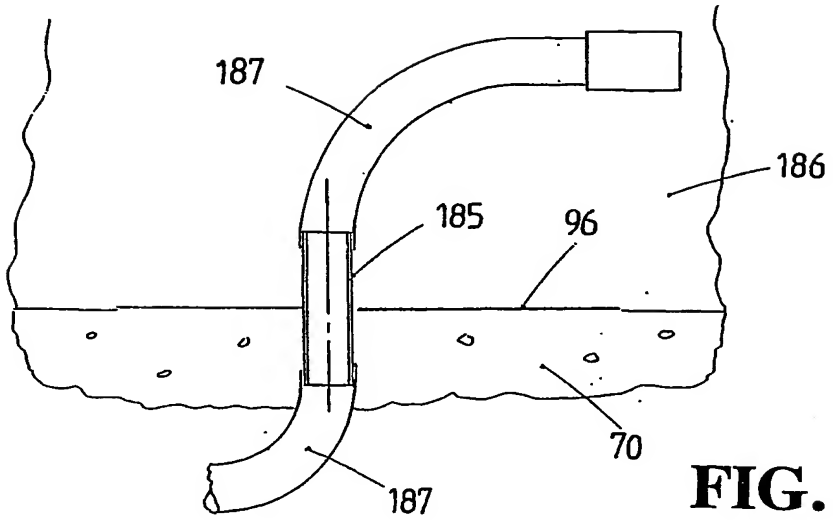


FIG. 49

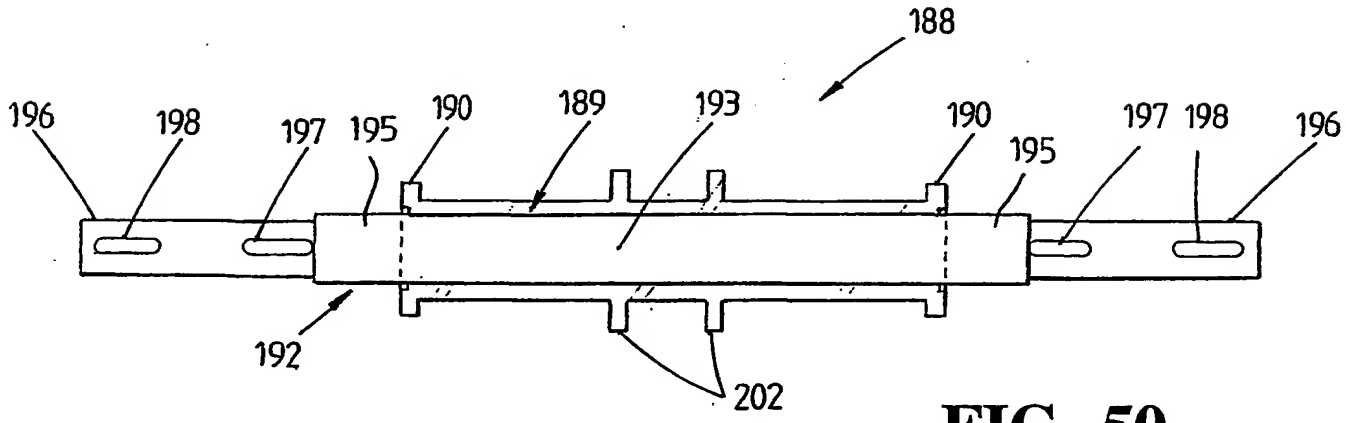


FIG. 50

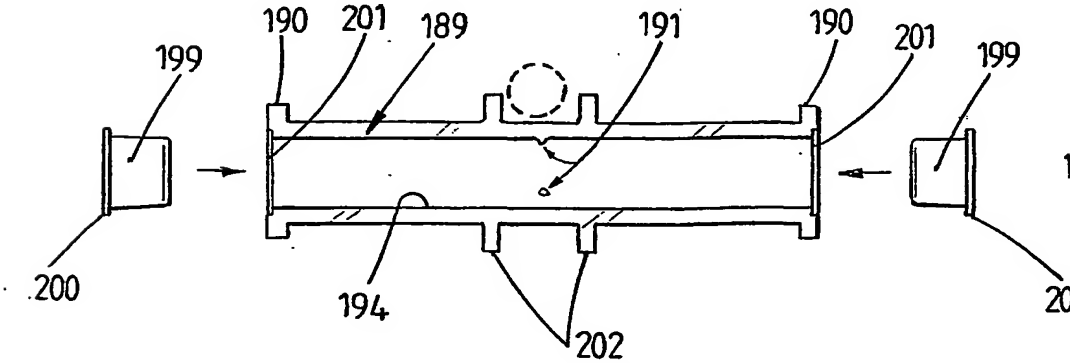


FIG. 51

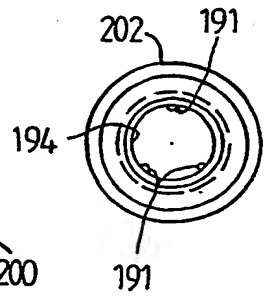


FIG. 52

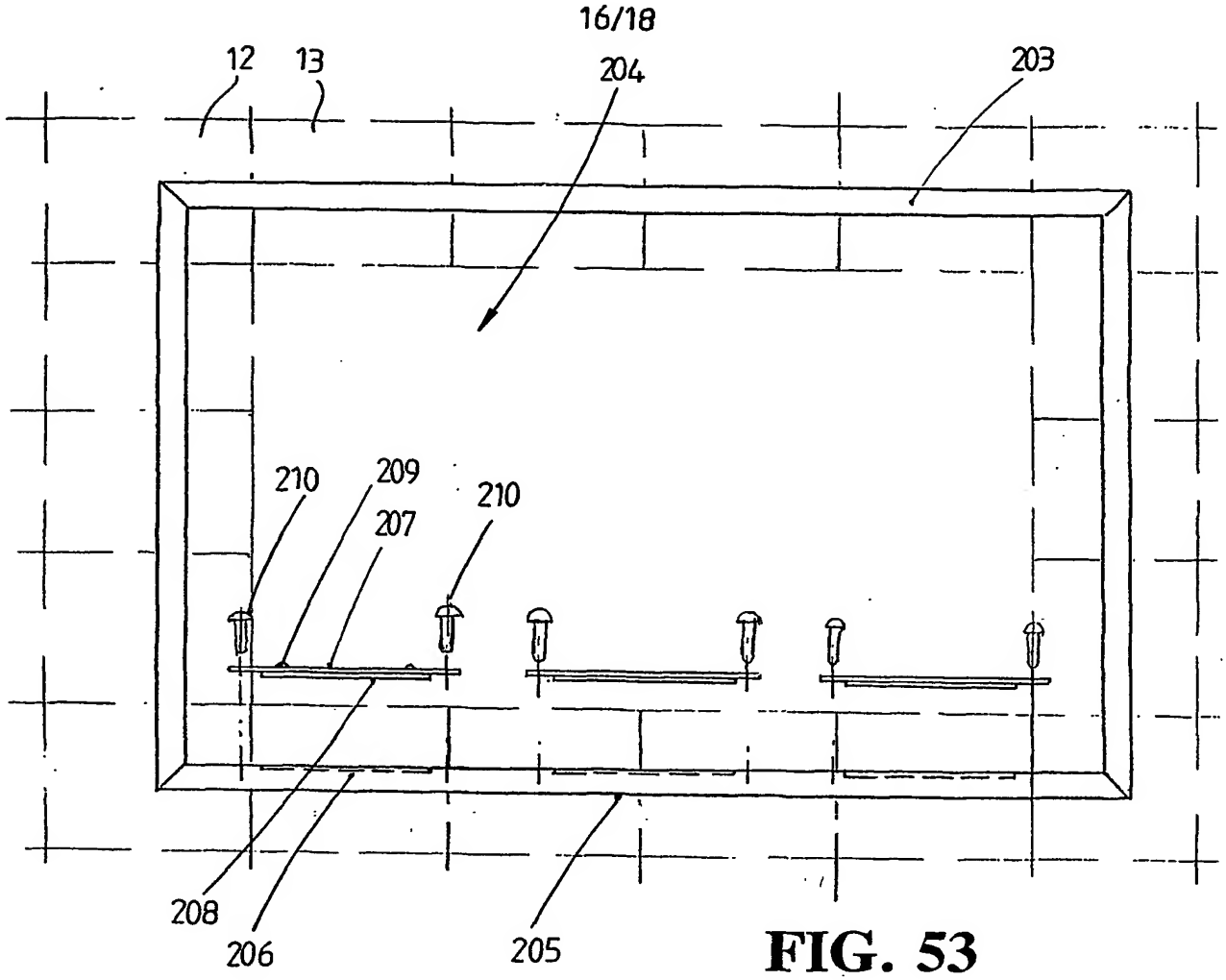


FIG. 53

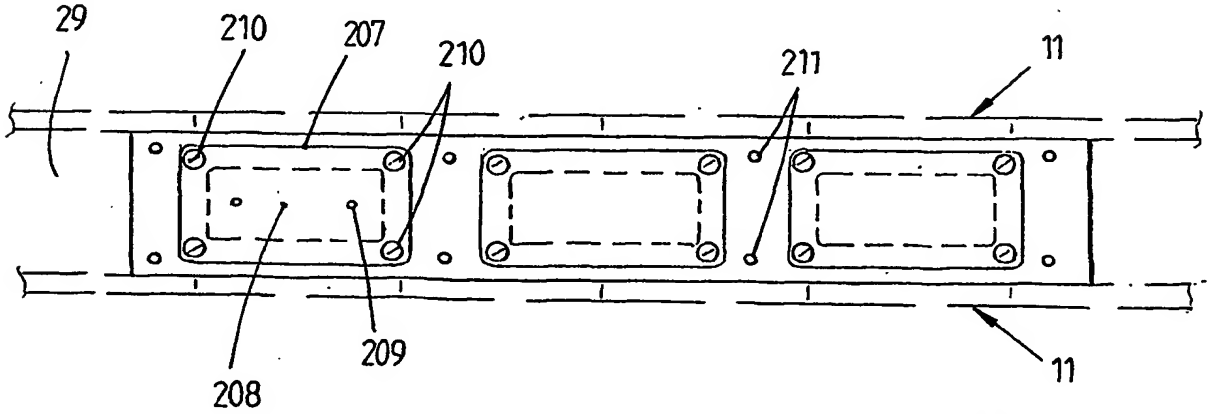


FIG. 54

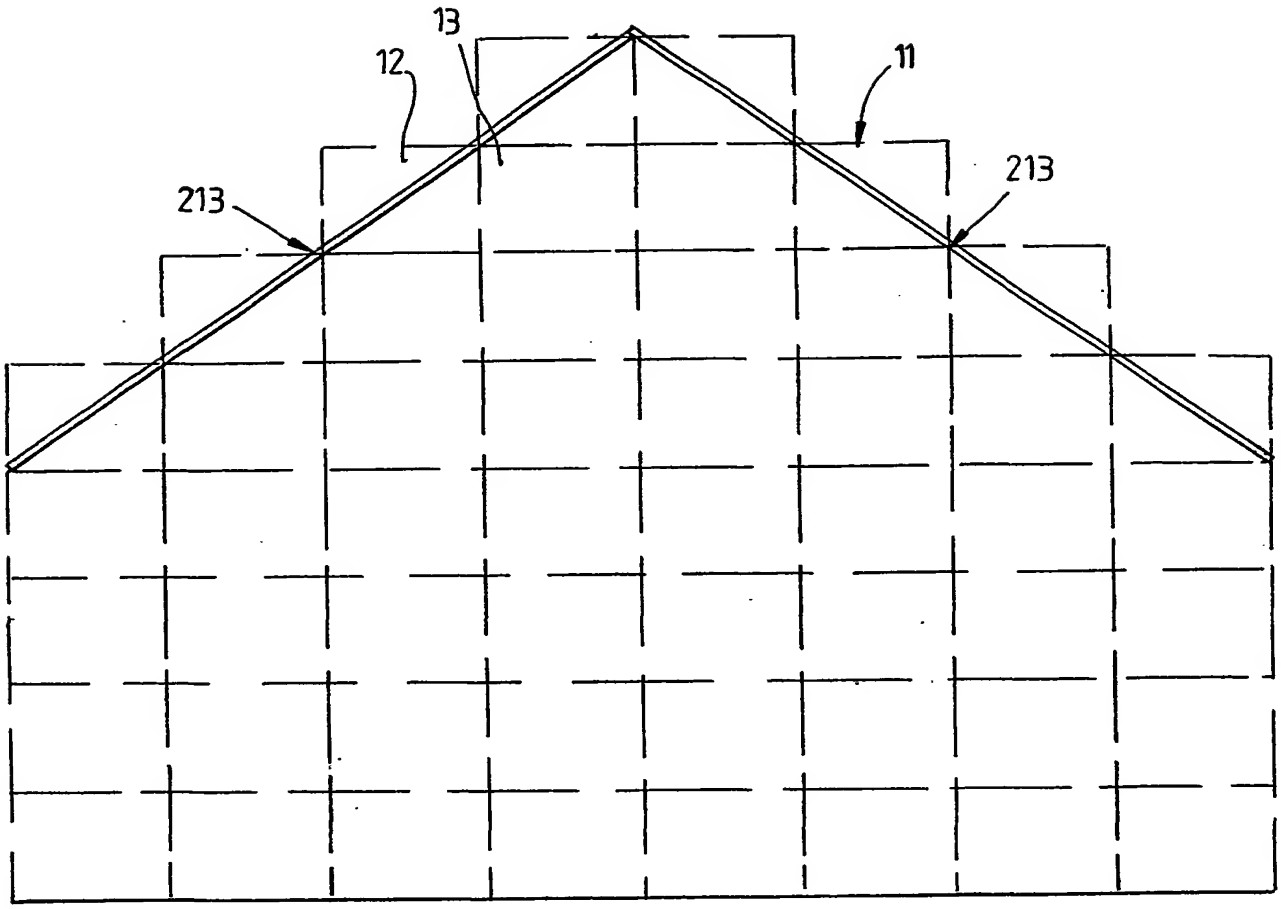


FIG. 55

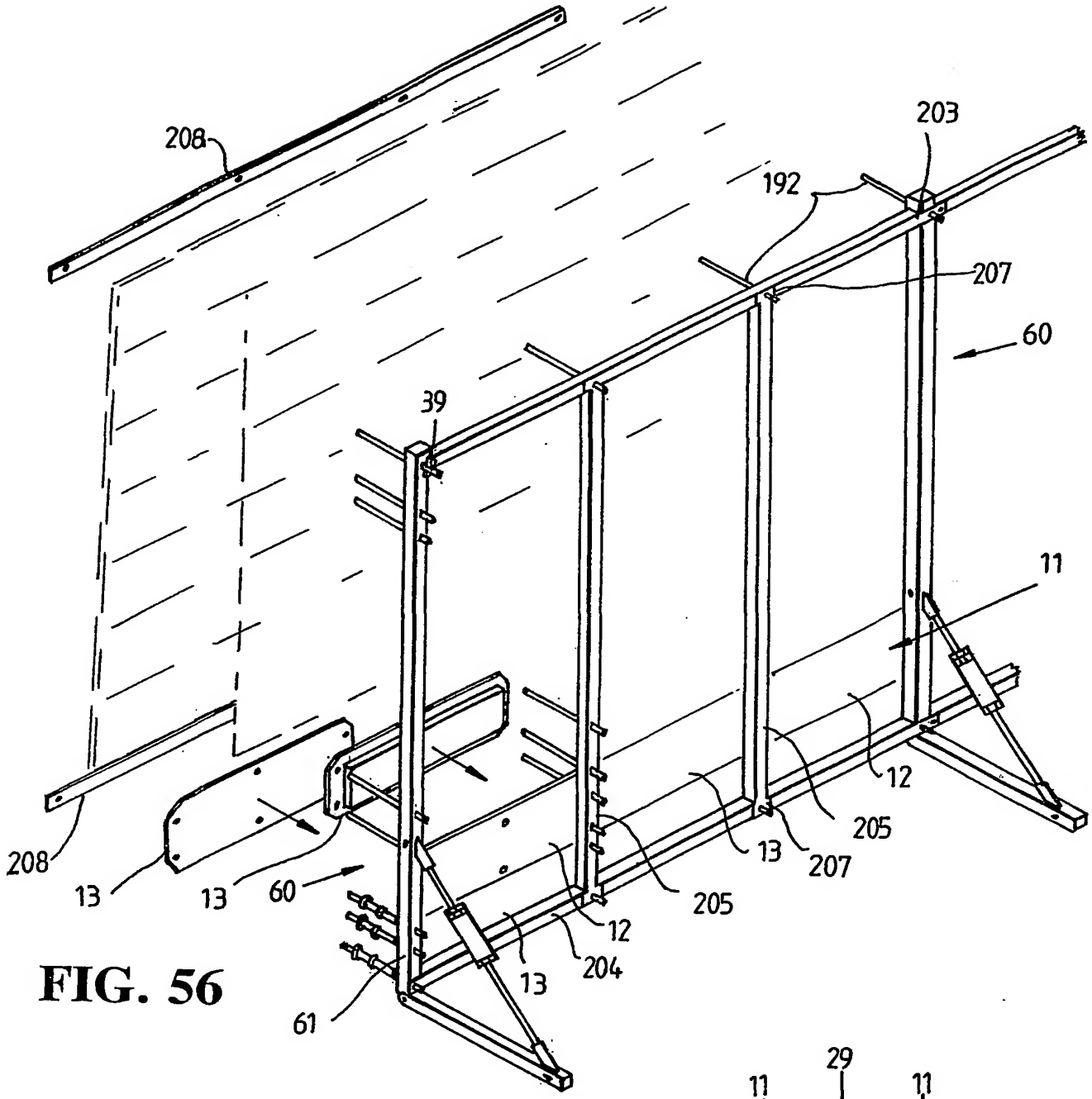


FIG. 56

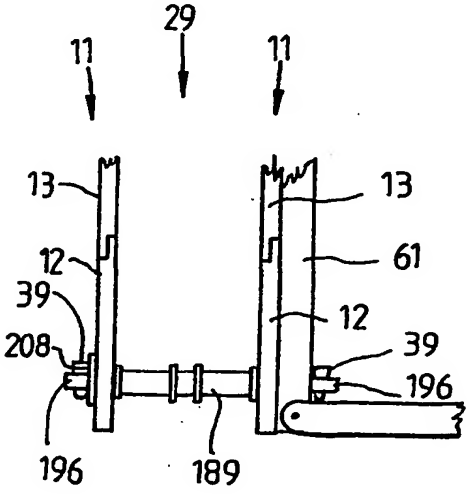


FIG. 57

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU02/00022

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. [7]: E04G 11/10, 17/06, 17/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
REFER ELECTRONIC DATA BASE CONSULTED BELOW

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU:IPC E04G 11/10, 17/06, 17/14

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
DWPI & keywords: spac, tie, brac, screw, bolt, bridg, inter, link, connect, coupl, join, attach, secur, panel, sheet, modul, plate, board, overlap, overlie, adjacent, E04G 11/-, 17/-, hole, align, flex, sleeve, adjust etc.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5065561 A (MASON) 19 November 1991 See figures.	1,2,6,9,14-16,30,33-59,60,61,63
X	US 4889310 A (BOESHART) 26 December 1989 See figures.	1,2,6,9,14-16,30,33-59,60,61,63
A	WO 91/02858 A (DANIELSEN) 7 March 1991 See figures.	

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search
15 May 2002

Date of mailing of the international search report
20 MAY 2002

Name and mailing address of the ISA/AU

AUSTRALIAN PATENT OFFICE
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Authorized officer

SUE THOMAS
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Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU02/00022

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 01/83178 A1 (JANEWAY) 8 November 2001 See figures.	
A	US 5890337 A (BOESHART) 6 April 1999 See figures.	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU02/00022

Box I **Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos :
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos :
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos :
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box II **Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

1. Claims 1 to 64 are directed to an apparatus and a method of constructing a wall using opposing moulds made up of mould panels whose peripheral portions overlap adjacent panels with the moulding surfaces substantially coplanar, with interconnecting means for holding the opposing moulds at a desired spacing and also extending through the overlapping portions to connect the adjacent panels. continued on extra sheet.

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☒ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

Supplemental Box
(To be used when the space in any of Boxes I to VIII is not sufficient)

Continuation of Box No: II

It is considered that the dual capacity of the interconnecting means to space the moulds and connect adjacent panels comprises a first "special technical feature".

2. Claims 65 to 70 are directed to opposing mould panels with transversely aligned apertures with flexible elements which interact with the spacing interconnecting means to allow limited longitudinal movement of the panels relative to the interconnecting means. The flexible element is considered to comprise a second separate "special technical feature".

Since the abovementioned groups of claims do not share either of the technical features identified, a "technical relationship" between the inventions, as defined in PCT rule 13.2 does not exist. Accordingly the international application does not relate to one invention or to a single inventive concept.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/AU02/00022

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	5065561	CA	1330713				
US	4889310	NIL					
WO	9102858	AU	58297/90	AU	61463/90	NO	893260
		WO	90/15205	SE	8902401		
WO	01/83178	NIL					
US	5890337	NIL					

END OF ANNEX